TO: Thai Hoang
FROM: Pamela Reynolds
SUBJECT : Online search
DATE: April 26, 2002

Dear Thai Hoang

Please find attached the search results for 09/715275.

I used the search strategy based on the IEC tutorial pages you gave to me.

If you would like a re-focus please let me know.

If we receive a response from the IEC organization we will let you know.

Thank you.

Pamela Reynolds
EIC 2600 Team Leader
306-0255
3C03

Access DB# 65397

54

SEARCH REQUEST FORM

Scientific and Technical Information Center

Requester's Full Name: Thai Hoang Examiner # : Date:
Art Unit: 2662 Phone Number 305-3232 Serial Number: 09/[redacted]715275
Mail Box and Bldg/Room Location: 4B23T02 Results Format Preferred (circle): PAPER DISK E-MAIL

If more than one search is submitted, please prioritize searches in order of need.

Please provide a detailed statement of the search topic, and describe as specifically as possible the subject matter to be searched. Include the elected species or structures, keywords, synonyms, acronyms, and registry numbers, and combine with the concept or utility of the invention. Define any terms that may have a special meaning. Give examples or relevant citations, authors, etc, if known. Please attach a copy of the cover sheet, pertinent claims, and abstract.

Title of Invention:

Inventors (please provide full names):

Earliest Priority Filing Date: ≤ 11-17-2010

***For Sequence Searches Only* Please include all pertinent information (parent, child, divisional, or issued patent numbers) along with the appropriate serial number.**

Ethernet Passive Optical Network(s)
or
EPON(s)
&
Frame formats

STAFF USE ONLY	Type of Search	Vendors and cost where applicable
Searcher: Pamela Reynolds	NA Sequence (#)	STN
Searcher Phone #: 306-0255	AA Sequence (#)	Dialog
Searcher Location: EIC03	Structure (#)	Questel/Orbit
Date Searcher Picked Up: 4-26	Bibliographic ✓	Dr.Link
Date Completed: 4-26	Litigation	Lexis/Nexis
Searcher Prep & Review Time: 90	Fulltext	Sequence Systems
Clerical Prep Time:	Patent Family	WWW/Internet ✓
Online Time: 90	Other	Other (specify)

PTO-1590 (1-2000)

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File 348:EUROPEAN PATENTS 1978-2002/APR W03
         (c) 2002 European Patent Office
File 349:PCT FULLTEXT 1983-2002/UB=20020425,UT=20020418
         (c) 2002 WIPO/Univentio

Set     Items   Description
S1          0   ETHERNET()PASSIVE()OPTICAL?()NETWORK?
S2       3804   EPON??
S3     221040   FRAME?
S4         19   ETHERNET(S)PASSIVE(S)OPTICAL?(S)NETWORK?
S5         34   ONU(S)FRAME?(S)OPTICAL?(S)NETWORK?
S6         19   ONU(S)TIME()SLOTS
S7      10414   S3(S)(DOWNSTREAM? OR UPSTREAM? OR (DOWN OR UP)()STREAM?)
S8         19   (EPON OR EPONS OR ONU)(S)TIME(5N)SLOTS
S9        165   AU=(KUO J? OR KUO, J? OR GRUIA D? OR GRUIA, D? OR KRAMER G?
              OR KRAMER, G? OR PESAVENTO G? OR PESAVENTO, G?)
S10         0   (S2 OR S4)(S)S9
S11         0   (S2 OR S4) AND S9
S12         5   (S2 OR S4)(10N)S3
S13         0   S12(S)ONU(S)TIME?
S14        45   S5 OR S6 OR S8
S15        44   S14 NOT AD=20001117:20020426
S16        14   S15(S)(DOWNSTREAM? OR UPSTREAM? OR (DOWN OR UP)()STREAM?)
```

12/3,K/1 (Item 1 from file: 348)
DIALOG(R)File 348:EUROPEAN PATENTS
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00280038
CELLULAR METHOD FOR DETERMINING TISSUE OF ORIGIN.
ZELLULARES VERFAHREN ZUR BESTIMMUNG DES ORIGINALEN GEWEBES.
PROCEDE CELLULAIRE POUR LA DETERMINATION DU TISSU D'ORIGINE.
PATENT ASSIGNEE:
MASSACHUSETTS INSTITUTE OF TECHNOLOGY, (210190), 77 Massachusetts Avenue, Cambridge, MA 02139, (US), (applicant designated states: AT;BE;CH;DE;FR;GB;IT;LI;LU;NL;SE)
INVENTOR:
PENMAN, Sheldon, 123 Fuller Street, Brookline, MA 02146, (US)
FEY, Edward, G., 80 Commercial Street, Boston, MA 02109, (US)
LEGAL REPRESENTATIVE:
Bassett, Richard Simon et al (52833), ERIC POTTER & CLARKSON St. Mary's Court St. Mary's Gate, Nottingham NG1 1LE, (GB)
PATENT (CC, No, Kind, Date): EP 250589 A1 880107 (Basic)
EP 250589 A1 901128
EP 250589 B1 951011
WO 8703910 870702
APPLICATION (CC, No, Date): EP 87902883 861223; WO 86US2798 861223
PRIORITY (CC, No, Date): US 812955 851224
DESIGNATED STATES: AT; BE; CH; DE; FR; GB; IT; LI; LU; NL; SE
INTERNATIONAL PATENT CLASS: C12Q-001/02; C12Q-001/68; G01N-033/53; A61K-038/16; A61K-039/395; C07H-015/12;
NOTE:
No A-document published by EPO
LANGUAGE (Publication,Procedural,Application): English; English; English
FULLTEXT AVAILABILITY:

Available Text	Language	Update	Word Count
CLAIMS B	(English)	EPAB95	2923
CLAIMS B	(German)	EPAB95	2593
CLAIMS B	(French)	EPAB95	3436
SPEC B	(English)	EPAB95	4967
Total word count - document A			0
Total word count - document B			13919
Total word count - documents A + B			13919

...SPECIFICATION spots on the gel precludes more precise analysis.
To obtain further information, the remaining skeletal **framework** , usually masked in conventional **Epon** -embedded thin section, can be visualized in three

12/3,K/2 (Item 1 from file: 349)
DIALOG(R)File 349:PCT FULLTEXT
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00840360 **Image available**
FIBER TO THE HOME (FTTH) MULTIMEDIA ACCESS SYSTEM
SYSTEME D'ACCES MULTIMEDIA A FIBRE JUSQU'A L'ABONNE (FTTH)
Patent Applicant/Assignee:
MARCONI COMMUNICATIONS INC, 5900 Landerbrook Drive, Cleveland, OH 44124, US, US (Residence), US (Nationality)
Inventor(s):
KIMBROUGH Mahlon D, 2301 Caldwell Drive, Bedford, TX 76021, US,
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GAINER James, 1541 Sarah Brooks Drive, Keller, TX 76248, US,
ETHRIDGE Barry, 4117 Periwinkle Drive, Fort Worth, TX 76137, US,
Legal Representative:
COCHRAN David B (et al) (agent), Jones, Day, Reavis & Pogue, North Point, 901 Lakeside Avenue, Cleveland, OH 44114, US,
Patent and Priority Information (Country, Number, Date):
Patent: WO 200174077 A1 20011004 (WO 0174077)

Application: WO 2001US7731 20010312 (PCT/WO US0107731)
Priority Application: US 2000537022 20000328
Designated States: AE AG AL AM AT AU AZ BA BB BG BR BY BZ CA CH CN CR CU CZ DE DK DM DZ EE ES FI GB GD GE GH GM HR HU ID IL IN IS JP KE KG KP KR KZ LC LK LR LS LT LU LV MA MD MG MK MN MW MX MZ NO NZ PL PT RO RU SD SE SG SI SK SL TJ TM TR TT TZ UA UG UZ VN YU ZA ZW
(EP) AT BE CH CY DE DK ES FI FR GB GR IE IT LU MC NL PT SE TR
(OA) BF BJ CF CG CI CM GA GN GW ML MR NE SN TD TG
(AP) GH GM KE LS MW MZ SD SL SZ TZ UG ZW
(EA) AM AZ BY KG KZ MD RU TJ TM
Publication Language: English
Filing Language: English
Fulltext Word Count: 15880

Fulltext Availability:
Detailed Description

Detailed Description
... Optical
Network; POTS means Plain Old Telephone Systems; PPPOE means Point-to
Point Protocol Over **Ethernet** ; SS means Supervisory System; SWX means
Splitter WDM **Frame** ; TCP/IP means Transmission Control
Protocol/Internet
Protocol; TDM means Time Division Multiplex; TSI means...

12/3,K/3 (Item 2 from file: 349)
DIALOG(R)File 349:PCT FULLTEXT
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00775199
KERATINOCYTE DERIVED INTERFERON
INTERFERON DERIVE DU KERATINOCYTE
Patent Applicant/Assignee:
HUMAN GENOME SCIENCES INC, 9410 Key West Avenue, Rockville, MD 20850, US, US (Residence), US (Nationality), (For all designated states except: US)
Patent Applicant/Inventor:
RUBEN Steven M, 18528 Heritage Hills Drive, Olney, MD 20832, US, US (Residence), US (Nationality), (Designated only for: US)
MOORE Paul A, 19005 Leatherbark Drive, Germantown, MD 20874, US, US (Residence), GB (Nationality), (Designated only for: US)
LAFLEUR David W, 3142 Quesada Street, Washington, DC 20015, US, US (Residence), US (Nationality), (Designated only for: US)
Legal Representative:
MARKS Michelle S, Human Genome Sciences, Inc., 9410 Key West Avenue, Rockville, MD 20850, US
Patent and Priority Information (Country, Number, Date):
Patent: WO 200107608 A1 20010201 (WO 0107608)
Application: WO 2000US1239 20000120 (PCT/WO US0001239)
Priority Application: US 99358587 19990721; WO 99US16424 19990721
Designated States: AE AL AM AT AU AZ BA BB BG BR BY CA CH CN CU CZ DE DK EE ES FI GB GD GE GH GM HR HU ID IL IN IS JP KE KG KP KR KZ LC LK LR LS LT LU LV MD MG MK MN MW MX NO NZ PL PT RO RU SD SE SG SI SK SL TJ TM TR TT UA UG US UZ VN YU ZA ZW
(EP) AT BE CH CY DE DK ES FI FR GB GR IE IT LU MC NL PT SE
(OA) BF BJ CF CG CI CM GA GN GW ML MR NE SN TD TG
(AP) GH GM KE LS MW SD SL SZ TZ UG ZW
(EA) AM AZ BY KG KZ MD RU TJ TM
Publication Language: English
Filing Language: English
Fulltext Word Count: 127533

Fulltext Availability:
Detailed Description

Detailed Description
... Isolated nucleic acid molecules of the present invention include DNA

molecules comprising an open reading **frame** (ORF) with an initiation codon at positions 35-37 of the nucleotide sequence shown in...

12/3,K/4 (Item 3 from file: 349)

DIALOG(R)File 349:PCT FULLTEXT
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00515977

PROCESS FOR PRODUCING DIRECT TOOLING MOLD AND METHOD FOR USING THE SAME
PROCEDE DE PRODUCTION DE MOULES D'USINAGE DIRECT ET PROCEDE D'UTILISATION DE CE MOULE

Patent Applicant/Assignee:
CIBA SPECIALTY CHEMICALS HOLDING INC,
Inventor(s):
KOTNIS Mahesh Arvind,
KUKULIES Brian Heinz,
FILIPIAK Kenneth Robert,
SCHWARTING David Douglas,
Patent and Priority Information (Country, Number, Date):
Patent: WO 9947329 A1 19990923
Application: WO 99EP1434 19990305 (PCT/WO EP9901434)
Priority Application: US 9839765 19980316
Designated States: AU CA CN IL JP KR AT BE CH CY DE DK ES FI FR GB GR IE IT LU MC NL PT SE
Publication Language: English
Fulltext Word Count: 7608

Fulltext Availability:
Detailed Description

Detailed Description
... 1 (a)) and cavity (Figure 1 (b)) were then sealed and assembled into a suitable **frame** and products molded.

2. Use of **epoNy** board(s) to produce polypropy[pne
ABS and/or polycarbonate protolype
Tools prepared from epoxy...

12/3,K/5 (Item 4 from file: 349)

DIALOG(R)File 349:PCT FULLTEXT
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00495074 **Image available**

SYSTEM AND METHOD FOR ELECTRONICALLY IDENTIFYING CONNECTIONS OF A CROSS-CONNECT SYSTEM
SYSTEME ET PROCEDE POUR L'IDENTIFICATION ELECTRONIQUE DE CONNEXIONS D'UN REPARTITEUR

Patent Applicant/Assignee:
ADC TELECOMMUNICATIONS INC,
Inventor(s):
KOZIY Robert J,
PFEIFFER Gregory C,
DANZINGER Leah E,
KELLER John C,
SIT Eric Kar-Wing,
Patent and Priority Information (Country, Number, Date):
Patent: WO 9926426 A1 19990527
Application: WO 98US24447 19981117 (PCT/WO US9824447)
Priority Application: US 97972159 19971117
Designated States: AL AM AT AU AZ BA BB BG BR BY CA CH CN CU CZ DE DK EE ES FI GB GE GH HU IL IS JP KE KG KP KR KZ LC LK LR LS LT LU LV MD MG MK MN MW MX NO NZ PL PT RO RU SD SE SG SI SK SL TJ TM TR TT UA UG UZ VN YU ZW GH GM KE LS MW SD SZ UG ZW AM AZ BY KG KZ MD RU TJ TM AT BE CH CY DE ES FI FR GB GR IE IT LU MC NL PT SE BF BJ CF CG CI CM GA GN GW ML M SN TD TG
Publication Language: English

Fulltext Word Count: 17207

Fulltext Availability:
Claims

Claim
... the crossconnect apparatuses of the type shown in Fig. 1 are typically installed in equipment **frames** or bays and interconnected as part of a telephony **network** . The cross-connect bays serve as a centralized hubs for interconnecting various types of equipment...
?

16/3,K/1 (Item 1 from file: 348)
DIALOG(R)File 348:EUROPEAN PATENTS
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01385742
Method and system for providing end-to-end protection in point-to-multipoint access networks
Verfahren und System zum Ende-zu-Ende Schutz in Punkt-zu-Multipunkt Zugangsnetzwerken
Methode et systeme de protection bout en bout dans des reseaux d'acces point a multipoint
PATENT ASSIGNEE:
LUCENT TECHNOLOGIES INC., (2143720), 600 Mountain Avenue, Murray Hill, New Jersey 07974-0636, (US), (Applicant designated States: all)
INVENTOR:
Muys, Wouteru, Goudvink 8, 3752 NP Bunschoten, (NL)
Steltenpool, Henk J., Dopperstraat 31, 3752 JA Bunschoten, (NL)
Wiebenga, Edward, Jivestraat 44, 1326 PJ Almere, (NL)
LEGAL REPRESENTATIVE:
Buckley, Christopher Simon Thirsk et al (28912), Lucent Technologies (UK) Ltd, 5 Mornington Road, Woodford Green, Essex IG8 0TU, (GB)
PATENT (CC, No, Kind, Date): EP 1176765 A1 020130 (Basic)
APPLICATION (CC, No, Date): EP 2000306300 000724;
DESIGNATED STATES: AT; BE; CH; CY; DE; DK; ES; FI; FR; GB; GR; IE; IT; LI; LU; MC; NL; PT; SE
EXTENDED DESIGNATED STATES: AL; LT; LV; MK; RO; SI
INTERNATIONAL PATENT CLASS: H04L-012/56; H04Q-011/00
ABSTRACT WORD COUNT: 126
NOTE:
Figure number on first page: 1

LANGUAGE (Publication,Procedural,Application): English; English; English
FULLTEXT AVAILABILITY:

Available Text	Language	Update	Word Count
CLAIMS A	(English)	200205	690
SPEC A	(English)	200205	2794
Total word count - document A			3484
Total word count - document B			0
Total word count - documents A + B			3484

...SPECIFICATION 983.1, comprising one or more redundant parts of the ATM-PON system. For reliability, **networks** may use diverse routes to each terminal to protect against cable cuts, and duplicated transmission ...

...switching. Automatic switching is forced by fault detection, such as loss of signal, loss of **frame** , signal degradation (the bit error rate falls below a predetermined threshold), etc. Forced switching occurs...

...the ATM-PON system and are implemented in physical layer OAM (PL-OAM) cells transmitted **downstream** the ODN (from OLT to all **ONU** 's). Several types of physical architecture are being proposed to provide end-to-end protection, of which the simplest only doubles the **optical** fibres of the ODN between the OLT and the **optical** splitter, and thus only provides for protection of the **optical** fibre between OLT and **optical** splitter by forced switching.
A second alternative doubles the OLT receiver/transmitter and the optical...

16/3,K/2 (Item 2 from file: 348)
DIALOG(R)File 348:EUROPEAN PATENTS
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01322523
Method and apparatus for TDM/TDMA communications
Verfahren und Vorrichtung zur TDM/TDMA-Kommunikation
Procede et dispositif de communications par transmission a multiplexage

dans le temps et AMRT

PATENT ASSIGNEE:
LUCENT TECHNOLOGIES INC., (2143720), 600 Mountain Avenue, Murray Hill, New Jersey 07974-0636, (US), (Applicant designated States: all)
INVENTOR:
Blahut, Donald Edgar, 9 Stevens Drive, Holmdel, New Jersey 07733, (US)
LEGAL REPRESENTATIVE:
Watts, Christopher Malcolm Kelway, Dr. et al (37391), Lucent Technologies (UK) Ltd, 5 Mornington Road, Woodford Green Essex, IG8 0TU, (GB)
PATENT (CC, No, Kind, Date): EP 1130841 A1 010905 (Basic)
APPLICATION (CC, No, Date): EP 2000307837 000911;
PRIORITY (CC, No, Date): US 515947 000229
DESIGNATED STATES: AT; BE; CH; CY; DE; DK; ES; FI; FR; GB; GR; IE; IT; LI; LU; MC; NL; PT; SE
EXTENDED DESIGNATED STATES: AL; LT; LV; MK; RO; SI
INTERNATIONAL PATENT CLASS: H04L-005/14
ABSTRACT WORD COUNT: 319
NOTE:
Figure number on first page: 1

LANGUAGE (Publication,Procedural,Application): English; English; English
FULLTEXT AVAILABILITY:

Available Text	Language	Update	Word Count
CLAIMS A	(English)	200136	1927
SPEC A	(English)	200136	7795
Total word count - document A			9722
Total word count - document B			0
Total word count - documents A + B			9722

...ABSTRACT A1

In a power splitting passive **optical network** (PSPON) (101) which provides fiber-to-the-home (FTTH), time division multiplexing/time division multiple access (TDM/TDMA) communication is employed for **downstream / upstream** transmission over a fiber. A **framed** structure is used for the **downstream** transmission of ATM cells from an **optical** line card (OLC) to a splitter (104) in the outside plant and thence to a plurality of **optical network** units (ONUs) (106) which are each associated with a home or business. The **ONU** at each home/business is connected to end user terminal equipment such as one or...

...PCs (109), televisions (111), and telephones (107). The ATM cells transmitted within each fixed length **frame** may be addressed to a specific **ONU** for a particular end user terminal, or they may be broadcast to many or all...

...ATM cell may also carry a control channel or messages directed to the ONUs. A **framed** structure is also employed for **upstream** burst transmission from the plural ONUs to the OLC. Specifically, in the **upstream** direction each **ONU** transmits one burst per **frame** that includes a header and a payload containing a variable number of bytes. The length of each payload in a burst transmitted **upstream** by an **ONU** is determined as a function of the bandwidth requirements of the end user terminal equipment connected to that **ONU** as well as the bandwidth requirements of the end user terminal equipment at the other ONUs. When the bandwidth requirements at an **ONU** changes, that information is communicated **upstream** to the OLC where an **upstream** bandwidth message is created and transmitted **downstream** to the ONUs. That **upstream** bandwidth management message modifies the length of the payload in the burst in a subsequent **frame** transmitted by that **ONU** whose bandwidth requirements have changed, and also changes the locations within the **frame** that the other ONUs transmit their bursts if they transmit in the **frame** after that payload-length modified **ONU** .

...SPECIFICATION sets, such as 118, connected to the network.

In the embodiment of the present invention, **downstream** transmission between the **network** end 103 over PSPON fiber 102 to the up to 32 fibers 105-1 - 105-32, which are each connected to an **ONU** , is in a TDM fixed **frame** format that consists of a total 2430 bytes transmitted at an 8000 **frames** /sec rate. **Downstream optical** transmission over the fiber 102

is at a 1550 nm wavelength. Each **frame** includes a 3 byte framing pattern, leaving a 2427 byte payload. For purposes of the present embodiment, all **downstream** payload data is formatted as ATM cells. Each cell includes 48 bytes of payload with a 5 byte ATM header. Since each ATM cell is 53 bytes long and the **frame** payload is not integrally divisible by 53, each **frame** boundary is typically spanned by an ATM cell. Each **downstream** ATM cell contains what may be either video MPEG data, IP data, or other data...

...be addressed, for example, to only the single end user's PC 109 connected to **ONU** 106. Digitized voice data from the station sets connected to PSTN 115 are broadcast on fiber 102 to each **ONU** connected to fibers 105-1 (horizontal bar) 105-32. Specifically, two DS1 **frames** , each consisting of 24 digitized DS0 voice channels are combined in a 48 byte channel payload for a dedicated ATM virtual circuit (VC). By transmitting **downstream** one such ATM cell per **frame** , forty-eight 64 kbit/sec **downstream** channels are provided corresponding to voice channels. Each **ONU** then extracts from that ATM cell in each **frame** the byte that is assigned to its active voice channel. If more, N, active telephone station sets are connected to an **ONU** , then N such bytes are extracted from that cell each **frame** , each byte being associated with one of the voice channels.

FIG. 2 illustrates a block...the OLC stores an upstream slot map. The upstream slot map identifies the sequence of **time slots** which make up a frame, each time slot containing a single transmission burst from one ...

...implemented as a list of up to 32 slot entries, which are stored in an **upstream** slot map memory, wherein each entry corresponds to each of the connected ONUs. The slot entry associated with each **ONU** identification parameter (0-31) defines the size and composition of the burst, containing both the...

...memory. Each slot entry 301 defines the size and composition of the burst associated with **ONU** identification parameter. The information thus includes ...burst. In addition, each entry contains information used for storing received ATM data from that **ONU** . This additional information consists of a cell pointer 304 to a cell buffer indicating where **upstream** ATM data should be written, and a byte offset 305 indicating where the next received...

...bursts across 53 frames if only one byte of payload is allocated to the associated **ONU** for transporting ATM data.

FIG. 4 is a block diagram of a single OLC 401...

16/3,K/3 (Item 3 from file: 348)

DIALOG(R)File 348:EUROPEAN PATENTS

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01079105

Architecture repartitioning to simplify outside-plant component of fibre-based access system

Verteilte Architektur zur Vereinfachung der externe Anlage von ein auf optischen Faser basiertes Zugangssystem

Architecture repartie, pour la simplification de l'installation externe d'un systeme d'acces, basee sur des fibres optiques

PATENT ASSIGNEE:

NORTEL NETWORKS CORPORATION, (217325), World Trade Center of Montreal 380 St. Antoine Street West 8th Floor, Montreal, Quebec H2Y 3Y4, (CA), (Applicant designated States: all)

INVENTOR:

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Morris, Todd Douglas, 5 Valerie Street, Stittsville, Ontario K2S 1L2, (CA)

Ellis, Donald Russels, 1131 Field Street, Ottawa, Ontario K2C 2P6, (CA)

LEGAL REPRESENTATIVE:

Ertl, Nicholas Justin et al (81413), Elkington and Fife, Prospect House,

8 Pembroke Road, Sevenoaks, Kent TN13 1XR, (GB)
PATENT (CC, No, Kind, Date): EP 949838 A2 991013 (Basic)
APPLICATION (CC, No, Date): EP 99302713 990407;
PRIORITY (CC, No, Date): US 56096 980407
DESIGNATED STATES: AT; BE; CH; CY; DE; DK; ES; FI; FR; GB; GR; IE; IT; LI; LU; MC; NL; PT; SE
EXTENDED DESIGNATED STATES: AL; LT; LV; MK; RO; SI
INTERNATIONAL PATENT CLASS: H04Q-011/00; H04Q-011/04; H04L-012/56
ABSTRACT WORD COUNT: 231
NOTE:
Figure number on first page: 1B

LANGUAGE (Publication,Procedural,Application): English; English; English
FULLTEXT AVAILABILITY:

Available Text	Language	Update	Word Count
CLAIMS A	(English)	9941	1255
SPEC A	(English)	9941	11235
Total word count - document A			12490
Total word count - document B			0
Total word count - documents A + B			12490

...SPECIFICATION being processed by the DSPs.

Preferably, the data being sent to the at least one **ONU** is organized into frames, wherein each frame comprises a number of **downstream** subframes, wherein each **downstream** subframe within a frame is destined for a particular **ONU** and comprises a traffic field sectioned into groups of **time slots** , wherein each group of **time slots** is destined for a separate line interface unit (LIU) in said **ONU** , wherein each LIU provides data in a specific format to a respective subscriber, the number of **time slots** in a group being dependent on the specific data format provided by the associated LIU...

...one ONU is organized into upstream subframes comprising a traffic field sectioned into groups of **time slots** , wherein each group of **time slots** originates from a separate LIU in the **ONU** , the number of slots in a group being dependent on the specific data format provided...16 and, according to a mapping controlled by the control processor 19, routes the individual **time slots** in each frame towards the appropriate transceiver 21. Similarly, the switch matrix 17 accepts **downstream** data from the transceivers 21, subdivides the data into traffic **time slots** that constitute a particular subframe that is routed to the appropriate **ONU** . This switch "fabric" also acts as a conduit to connect **ONU** signalling and control paths to the signalling, control and OAM processors 20,19,18.

The...with bits and dedicated to transmitting certain classes of information from the HDT to the **ONU** . The address field in each subframe identifies the **ONU** for which the traffic is destined. The signalling field preferably carries instructions (such as ringing needs for that LIU. The control channel in the **downstream** subframes also provides control of the codec sampling and output rates in each LIU, as well as precise timing instructions for the transmittal of bursts of **upstream** data.

The traffic field is divided into a multitude of (in this case, twenty-nine...

...will depend on the bandwidth granularity and on the type of service provided.

These same **time slots** are used in the analogous construction of **upstream** subframes transmitted by the **ONU** 102 to the HDT 101. The mux 105 forms a subframe that is subdivided into groups of **time slots** , whereby a group is associated with a specific LIU and is allotted a number of **time slots** that is dependent on the BG and on the required **upstream** bandwidth. Upon command from the HDT, an **ONU** transmits its fully constructed **upstream** subframe on a once-per-frame basis, although the subframes arriving from various ONUs are...

...The oversampled data 152 is fed to the mux 105, where a suitable number of **time slots** in a subframe are allotted to this stream. Also, the

mux 105 will partially fill...
...the loop status detector 10 via path 134. The address field will indicate the source **ONU** .
The mux 105 then assembles the time slots from each LIU, as well as all ...to the PON-OS 128. The PON-OS waits for the go-ahead from the **ONU** control processor 126 before sending the subframe onto the fiber 4 via the transceiver 6. The **ONU** control processor 126 receives this timing information from the HDT in the control field of the **downstream** subframes. Each **ONU** sharing the same fiber umbilical 4a is cyclically instructed to send its burst of data...

...called a guard band. This is designed to account for the delay in instructing one **ONU** to transmit while ensuring that the previous **ONU** has ceased transmission.
The train 400 of data containing the oversampled POTS signal of upstream...

16/3,K/4 (Item 4 from file: 348)
DIALOG(R)File 348:EUROPEAN PATENTS
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01015167
Coherent optical communication system
Koherentes optisches Nachrichtenubertragungssystem
Systeme de communication optique coherent
PATENT ASSIGNEE:
LUCENT TECHNOLOGIES INC., (2143720), 600 Mountain Avenue, Murray Hill, New Jersey 07974-0636, (US), (applicant designated states: AT;BE;CH;CY;DE;DK;ES;FI;FR;GB;GR;IE;IT;LI;LU;MC;NL;PT;SE)
INVENTOR:
Frigo, Nicholas J., 160 Ambassador Drive, Red Bank, New Jersey 07701, (US)
LEGAL REPRESENTATIVE:
Watts, Christopher Malcolm Kelway, Dr. et al (37391), Lucent Technologies (UK) Ltd, 5 Mornington Road, Woodford Green Essex, IG8 0TU, (GB)
PATENT (CC, No, Kind, Date): EP 910187 A2 990421 (Basic)
EP 910187 A3 990428
APPLICATION (CC, No, Date): EP 98307694 980922;
PRIORITY (CC, No, Date): US 940755 970930
DESIGNATED STATES: DE; FR; GB; IT; SE
INTERNATIONAL PATENT CLASS: H04B-010/26; H04B-010/148; H04B-010/207;
ABSTRACT WORD COUNT: 255

LANGUAGE (Publication,Procedural,Application): English; English; English
FULLTEXT AVAILABILITY:

Available Text	Language	Update	Word Count
CLAIMS A	(English)	9916	519
SPEC A	(English)	9916	3667
Total word count - document A			4186
Total word count - document B			0
Total word count - documents A + B			4186

...SPECIFICATION common signal to all end users. Information is segregated within the broadcast signal in individual **time slots** as a **time** division multiplexed (TDM) signal and/or sub-carrier multiplexed channels. A star coupler at the remote node distributes the broadcast signals to the optical network units. **Upstream** information is usually transmitted from each **ONU** within a particular time slot, received at the remote node, multiplexed and directed to the...

16/3,K/5 (Item 5 from file: 348)
DIALOG(R)File 348:EUROPEAN PATENTS
(c) 2002 European Patent Office. All rts. reserv.

00980924
Time multiplexing method, and related arrangements to be used in a central

station and network terminals of a communications network
Zeitmultiplexverfahren und zugehorige Anordnungen zur Verwendung in einer zentralen Station und Netzwerkendstellen eines Nachrichtenubertragungsn etzwerkes
Methode de multiplexage dans le temps et dispositif correspondant a usage dans une station centrale et terminaux de reseau de communication
PATENT ASSIGNEE:
ALCATEL, (201874), 54, rue La Boetie, 75008 Paris, (FR), (applicant designated states:
AT;BE;CH;DE;DK;ES;FI;FR;GB;GR;IE;IT;LI;LU;MC;NL;PT;SE)
INVENTOR:
Hoebeke, Rudy, C. Huysmanslaan 57, Bus 2, 2020 Antwerpen, (BE)
LEGAL REPRESENTATIVE:
Narmon, Gisele Marie Therese et al (83944), Alcatel Bell N.V. Intellectual Property Department Francis Wellesplein 1, 2018 Antwerpen, (BE)
PATENT (CC, No, Kind, Date): EP 889611 A1 990107 (Basic)
APPLICATION (CC, No, Date): EP 97401562 970702;
PRIORITY (CC, No, Date): EP 97401562 970702
DESIGNATED STATES: BE; DE; ES; FR; GB; IT; SE
INTERNATIONAL PATENT CLASS: H04J-003/16; H04N-007/173;
ABSTRACT WORD COUNT: 139

LANGUAGE (Publication,Procedural,Application): English; English; English
FULLTEXT AVAILABILITY:

Available Text	Language	Update	Word Count
CLAIMS A	(English)	9901	1141
SPEC A	(English)	9901	4128
Total word count - document A			5269
Total word count - document B			0
Total word count - documents A + B			5269

...SPECIFICATION in the art, e.g. from the proposal to the FSAN-OAN (Full Service Access **Network** - **Optical** Access **Network**) Workgroup entitled 'Short Slot Proposal'. This proposal is written by the authors Mark Bridger, Dan...

...Mike Haynes, and dated April 22-23, 1997. Therein, the central station of a passive **optical network** (PON) with point-to-multipoint architecture regularly broadcasts so called PLOAM (Physical Layer Operation Administration and Maintenance) cells containing identifiers of the **network** terminals which are allowed to send a burst in the **upstream** timeslots of an **upstream frame** . The central station in the **optical network** of the mentioned proposal is called the OLT (**Optical** Line Termination), whereas the **network** terminals are named **ONU** 's (**Optical Network** Units). The contents of such a PLOAM cell as proposed by Mark Bridger et al...

...page 4 of the just cited proposal. The 30 grant messages therein each contain an **ONU** identifier. Each **ONU** identified in the PLOAM cell is permitted to occupy one timeslot. By **downstream** broadcasting this message, all **ONU** 's in the **network** become aware of the order wherein they are allowed to occupy **upstream** timeslots for transmission of data bursts towards the OLT. The **upstream** timeslots may be standard full size **upstream** slots with a length of 56 bytes or short slots with a length of 7...

16/3,K/6 (Item 6 from file: 348)
DIALOG(R)File 348:EUROPEAN PATENTS
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00958736
Wavelength-division multiplexing in passive optical networks
Wellenlangen-Multiplexing in passiven optischen Netzwerken
Multiplexage de longueurs d'ondes dans des reseaux optiques passives
PATENT ASSIGNEE:
FUJITSU LIMITED, (211466), 1-1, Kamikodanaka 4-chome, Nakahara-ku,

Kawasaki-shi, Kanagawa 211-8588, (JP), (Applicant designated States: all)
INVENTOR:
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Robinson, Mark John, 3 Silverdale Close, Hanwell, London W7 3HR, (GB)
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PATENT (CC, No, Kind, Date): EP 869634 A2 981007 (Basic)
EP 869634 A3 020417
APPLICATION (CC, No, Date): EP 98300849 980205;
PRIORITY (CC, No, Date): GB 9704587 970305
DESIGNATED STATES: AT; BE; CH; DE; DK; ES; FI; FR; GB; GR; IE; IT; LI; LU; MC; NL; PT; SE
EXTENDED DESIGNATED STATES: AL; LT; LV; MK; RO; SI
INTERNATIONAL PATENT CLASS: H04J-014/02; H04B-010/207; H04J-003/16; H04J-003/24; H04Q-011/04
ABSTRACT WORD COUNT: 176
NOTE:
Figure number on first page: 2

LANGUAGE (Publication,Procedural,Application): English; English; English
FULLTEXT AVAILABILITY:

Available Text	Language	Update	Word Count
CLAIMS A	(English)	9841	1844
SPEC A	(English)	9841	9563
Total word count - document A			11407
Total word count - document B			0
Total word count - documents A + B			11407

...SPECIFICATION available which is allocated to the ONU 144)), enabling the ONU 144)) to have four **time slots** altogether within the **time** frame, equivalent to 1/2 U capacity. Initially, in **time slots** T1 and T2, the **ONU** 144)) receives data carried by the optical signal S2 having the second wavelength (lambda)2...
...by the optical signal S1 having the first wavelength (lambda)1 in the final two **time slots** T3 and T4.
As will be apparent from Figures 3(A) and 3(B), the...core network is received by the transmitter 48 in the ONU 14 and transmitted, at **time slots** determined by the TDMA format of the **upstream** traffic, to the OLT 12 at the single wavelength (lambda)x using the **upstream** PON.
In the first embodiment, the control information needed by the ONU may be included...

16/3,K/7 (Item 7 from file: 348)
DIALOG(R)File 348:EUROPEAN PATENTS
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00901494
Negotiation of bandwidth in a telecommunications network
Verhandeln von Bandbreite in einem Nachrichtenubertragungsnetzwerk
Negociation de debit dans un reseau de telecommunication
PATENT ASSIGNEE:
GPT LIMITED, (986784), New Century Park P.O. Box 53, Coventry, CV3 1HJ, (GB), (applicant designated states:
AT;BE;CH;DE;DK;ES;FI;FR;GB;GR;IE;IT;LI;LU;MC;NL;PT;SE)
INVENTOR:
Proctor, Richard John, 28 Diprose Road, Corfe Mullen, Wimborne, Dorset BH21 3QY, (GB)
LEGAL REPRESENTATIVE:
Branfield, Henry Anthony (45871), The General Electric Company, p.l.c. GEC Patent Department Waterhouse Lane, Chelmsford, Essex CM1 2QX, (GB)
PATENT (CC, No, Kind, Date): EP 822680 A2 980204 (Basic)
APPLICATION (CC, No, Date): EP 97305788 970731;
PRIORITY (CC, No, Date): GB 9616380 960803

DESIGNATED STATES: AT; BE; CH; DE; DK; ES; FI; FR; GB; GR; IE; IT; LI; LU; MC; NL; PT; SE
INTERNATIONAL PATENT CLASS: H04J-014/08; H04J-003/24; H04Q-011/04;
ABSTRACT WORD COUNT: 103

LANGUAGE (Publication,Procedural,Application): English; English; English
FULLTEXT AVAILABILITY:

Available Text	Language	Update	Word Count
CLAIMS A	(English)	9806	540
SPEC A	(English)	9806	3123
Total word count - document A			3663
Total word count - document B			0
Total word count - documents A + B			3663

...SPECIFICATION and in a low power mode it need only ever consider one stream.
In the **upstream** mode a **Network** Termination Equipment (NTE) or **Optical** **Network** Unit (**ONU**) could be assigned, on a longer term basis, additional-cell slots across any of the eight streams. Over a 250(mu)s **frame** there are thirty-two cell slots per stream, and eight streams. Any of these 256...

...when the load from any NTE gets too high. This allocation would be by the **Optical** Line Termination's (OLT's) main processor and can assign slots on relatively lightly loaded streams to particularly heavy NTE's. Thus the whole **upstream** bandwidth is available. This is a key feature of the invention.
There are considerations of...

16/3,K/8 (Item 8 from file: 348)
DIALOG(R)File 348:EUROPEAN PATENTS
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00846292
Optical communication system and remote sensor interrogation
Optisches Ubertragungssystem und Fernabfragesensor
Systeme de communication optique et capteur a interrogation a distance
PATENT ASSIGNEE:
LUCENT TECHNOLOGIES INC., (2143720), 600 Mountain Avenue, Murray Hill, New Jersey 07974-0636, (US), (Applicant designated States: all)
INVENTOR:
Frigo, Nicholas J., 26 Erie Road, Atlantic Highlands, Monmouth, New Jersey 07716, (US)
LEGAL REPRESENTATIVE:
Watts, Christopher Malcolm Kelway, Dr. et al (37391), Lucent Technologies (UK) Ltd, 5 Mornington Road, Woodford Green Essex, IG8 0TU, (GB)
PATENT (CC, No, Kind, Date): EP 782286 A2 970702 (Basic)
EP 782286 A3 010523
APPLICATION (CC, No, Date): EP 96309249 961218;
PRIORITY (CC, No, Date): US 579986 951229
DESIGNATED STATES: DE; ES; FR; GB; IT
INTERNATIONAL PATENT CLASS: H04B-010/26
ABSTRACT WORD COUNT: 115
NOTE:
Figure number on first page: 2

LANGUAGE (Publication,Procedural,Application): English; English; English
FULLTEXT AVAILABILITY:

Available Text	Language	Update	Word Count
CLAIMS A	(English)	EPAB97	532
SPEC A	(English)	EPAB97	4946
Total word count - document A			5478
Total word count - document B			0
Total word count - documents A + B			5478

...SPECIFICATION users served by a given node. Information is segregated within the broadcast signal in individual **time** **slots** as a **time**

division multiplexed (TDM) signal. A star coupler at the remote node distributes the broadcast signals to the optical network units. **Upstream** information is transmitted from each **ONU** within a particular time slot, received at the remote node, optically multiplexed and directed to ...

16/3,K/9 (Item 9 from file: 348)
DIALOG(R)File 348:EUROPEAN PATENTS
(c) 2002 European Patent Office. All rts. reserv.

00768066
One-dimensional optical data arrays implemented within optical networks
Eindimensionale optische Matrize fur optisches Netz
Matrices optiques unidimensionnelles mises en oeuvre dans des reseaux optiques
PATENT ASSIGNEE:
AT&T Corp., (589370), 32 Avenue of the Americas, New York, NY 10013-2412, (US), (applicant designated states: DE;ES;FR;GB;IT)
INVENTOR:
Frigo, Nicholas J., 26 Erie Road, Atlantic Highlands, New Jersey 07716, (US)
LEGAL REPRESENTATIVE:
Watts, Christopher Malcolm Kelway, Dr. et al (37391), Lucent Technologies (UK) Ltd, 5 Mornington Road, Woodford Green Essex, IG8 0TU, (GB)
PATENT (CC, No, Kind, Date): EP 720314 A1 960703 (Basic)
APPLICATION (CC, No, Date): EP 95309012 951212;
PRIORITY (CC, No, Date): US 366954 941230
DESIGNATED STATES: DE; ES; FR; GB; IT
INTERNATIONAL PATENT CLASS: H04B-010/207;
ABSTRACT WORD COUNT: 107
LANGUAGE (Publication,Procedural,Application): English; English; English
FULLTEXT AVAILABILITY:

Available Text	Language	Update	Word Count
CLAIMS A	(English)	EPAB96	552
SPEC A	(English)	EPAB96	3333
Total word count - document A			3885
Total word count - document B			0
Total word count - documents A + B			3885

...SPECIFICATION above.
In a preferred form, each return signal looped-back from each RITE-Net(TM) **optical network** unit (whether overmodulated or not) may be utilized as an interrogation signal. That is, each **downstream** directed signal interrogates the modulator and necessarily checks the **optical** continuity of the **optical** circuit. Thus, any break in the loop may be detected at the central office as a matter of course, almost immediately. A lack of response from the **ONU** over several **optical frames** , (e.g., 125(mu) sec.), indicates a line break and the central office takes appropriate action. While detecting a line fault in an active double star **network** will not aid in determining the exact location of the fault, the assignment of craft...

16/3,K/10 (Item 10 from file: 348)
DIALOG(R)File 348:EUROPEAN PATENTS
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00690103
An optical transmission system
Optisches Ubertragungssystem
Systeme de transmission optique
PATENT ASSIGNEE:
NIPPON TELEGRAPH AND TELEPHONE CORPORATION, (686339), 19-2 Nishi-Shinjuku 3-chome, Shinjuku-ku, Tokyo 163-19, (JP), (Proprietor designated states: all)
INVENTOR:
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Kanagawa, (JP)
Okada, Kenji, 3-13-3, Higashi-asahina, Kanazawa-ku, Yokohama-shi, Kanagawa, (JP)
LEGAL REPRESENTATIVE:
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PATENT (CC, No, Kind, Date): EP 658992 A1 950621 (Basic)
EP 658992 B1 020313
APPLICATION (CC, No, Date): EP 94402893 941215;
PRIORITY (CC, No, Date): JP 93318311 931217
DESIGNATED STATES: DE; FR; GB
INTERNATIONAL PATENT CLASS: H04J-014/08
ABSTRACT WORD COUNT: 176
NOTE:
Figure number on first page: 1

LANGUAGE (Publication,Procedural,Application): English; English; English
FULLTEXT AVAILABILITY:

Available Text	Language	Update	Word Count
CLAIMS A	(English)	EPAB95	946
CLAIMS B	(English)	200211	981
CLAIMS B	(German)	200211	896
CLAIMS B	(French)	200211	1121
SPEC A	(English)	EPAB95	6011
SPEC B	(English)	200211	5790
Total word count - document A			6958
Total word count - document B			8788
Total word count - documents A + B			15746

...ABSTRACT A1
In an **optical** transmission system between an **optical** subscriber unit (10; OSU) in a central office and a plurality of **optical network** units (20(sub(i)); **ONU**) in customer premises each coupled with said subscriber unit (10) through a single **optical** transmission line (32(sub(i))), an **optical** switch (40) is provided for selectively coupling one of said **network** units (20(sub(i))) to said subscriber unit (10) sequentially on time division multiplexing operation, so that no attenuation except small insertion loss by an **optical** switch occurs in switching. A **downstream frame** from said subscriber unit (10) to said **network** units (20(sub(i))) has a plurality of **time slots** each of which is to be switched to a predetermined related **network** unit, and de-multiplexed by said **optical** switch. Each time slot has no identification for addressing. An **upstream frame** from **network** units are multiplexed by said **optical** switch. Said **downstream frame** and said **upstream frame** are multiplexed in a single **optical** transmission line either through time division multiplexing or through wavelength multiplexing. (see image in original...

16/3,K/11 (Item 11 from file: 348)
DIALOG(R)File 348:EUROPEAN PATENTS
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00633116
Optical network based on remote interrogation of terminal equipment.
Optisches Netzwerk mit Endgeratfernabfrage.
Reseau optique base sur l'interrogation a distance d'un equipement terminal.
PATENT ASSIGNEE:
AT&T Corp., (589373), 32 Avenue of the Americas, New York, NY 10013-2412, (US), (applicant designated states: DE;ES;FR;GB;IT)
INVENTOR:
Darcie, Thomas Edward, 11 Ferrin Court, Middletown, New Jersey 07748, (US)
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Magill, Peter D., 1011 Robin Drive, Lakewood, New Jersey 08701, (US)
LEGAL REPRESENTATIVE:
Watts, Christopher Malcolm Kelway, Dr. et al (37391), AT&T (UK) Ltd. 5,

Mornington Road, Woodford Green Essex, IG8 0TU, (GB)
PATENT (CC, No, Kind, Date): EP 615358 A1 940914 (Basic)
APPLICATION (CC, No, Date): EP 94301667 940309;
PRIORITY (CC, No, Date): US 29724 930311
DESIGNATED STATES: DE; ES; FR; GB; IT
INTERNATIONAL PATENT CLASS: H04B-010/24
ABSTRACT WORD COUNT: 154

LANGUAGE (Publication,Procedural,Application): English; English; English
FULLTEXT AVAILABILITY:

Available Text	Language	Update	Word Count
CLAIMS A	(English)	EPABF2	1004
SPEC A	(English)	EPABF2	5912
Total word count - document A			6916
Total word count - document B			0
Total word count - documents A + B			6916

...SPECIFICATION TPON) and "Passive Photonic Loop" (PPL).

In a TPON architecture, the central office provides a **downstream** optical signal to each of the ONUs utilizing a time-division multiplexed protocol. This protocol typically comprises a frame of information that is further subdivided into **time slots** that are assigned to individual ONUs. Upon receiving the time-division multiplexed optical signal, each **ONU** then extracts the information that is contained in its assigned **time slots** . Consequently, each **ONU** must be synchronized to the transmission of the **downstream** optical signal to ensure that it correctly performs the demultiplexing operation. Similarly, in the **upstream** direction, from each **ONU** to the central office (through the RN), the operation of the **ONU** 's laser must be synchronized so that each **ONU** transmits information only in its assigned time slot so as to avoid interfering with the optical signals provided by the lasers of other ONUs. This synchronization in the **upstream** direction is further complicated by the effect of the different optical path lengths, between each **ONU** and the RN, on an **ONU** 's respective optical signal.

In comparison, the PPL architecture is different from the TPON architecture...division multiplexed signal comprises a time frame, t(sub(f)), which comprises a number of **time slots** , t(sub(i)), where each **time** slot is associated with a particular wavelength. In this particular example, each time slot is used to transmit a "packet" of information to the respective **ONU** although other effective techniques (like bit interleaving) can also be used. CO processor 15 controls...

...For example, during time slot t(sub 1), CO processor 15 provides information associated with **ONU** 100 to frequency tunable optical transmitter 20. At the same time, sequencer 30 controls frequency...

...of (lambda)(sub 1). As a result, frequency tunable optical transmitter 20 impresses information for **ONU** 100 onto an optical signal with a wavelength of (lambda)(sub 1). Packets (or bits) for the other ONUs are similarly transmitted in the other **time slots** at their respective different wavelengths. This results in a **downstream** optical beam comprising a number of optical signals each at a different wavelength and modulated by a **downstream** information signal.

Although other modulation techniques are possible, frequency tunable optical transmitter 20 illustratively uses...

...a "shallow modulation depth". A representative transmitted digital sequence is shown in FIG. 4 for **time slots** t(sub 1) to t(sub 3). It should be noted that the modulation rate...

...of bits per second, B, transmitted in each time slot can also vary for each **ONU** as can the format (multilevel etc.). This is also shown in FIG. 4, where the modulation rate B(sub 2) for **ONU** 200 during time slot t(sub 2) is lower than the modulation rates B(sub 1) and B(sub 3) for respective ONUs 100 and **ONU** 300. Similarly, the modulation rate for **ONU** 300, B(sub 3), is higher than the modulation rate for either **ONU** 100 or **ONU** 200.

The transmitted optical signal from CO 10 is accepted by RN 90. The

latter...CO processor 15 to take into account the various time delays before transmission of any **downstream** information. An illustrative method is shown in FIG. 7. Beginning with step 605, it is assumed that the length of a time **frame** , t(sub(f)), is known a priori. In this example, it is assumed that t(sub(f))=125(mu)sec(e.g.,SONET). As described above, during each **frame** a packet of **downstream** information is transmitted to each **ONU** . As a result, the size of each time slot is simply equal to t(sub(f))/N where N is the number of ONUs. For example, if **ONU** 100, **ONU** 200, **ONU** 300 and **ONU** 400 are representative of 16 ONUs, this results in 16 packets of information for each time **frame** , each packet being transmitted in a time slot of approximately 8(mu) sec. each. In step 610, CO processor 15 determines the **optical** path length, or time delay, (DELTA)(sub(i)), for each of the 16 ONUs before any **downstream** transmission of subscriber information takes place. This time ...the total time delay, (DELTA)(sub(total)), is determined by the physical length of the **network** . It is assumed that the physical length of the **network** of FIG. 1 is similar to that of a TPON **network** , which is 3.6 kilometers. This results in a value for (DELTA)(sub(total)) of approximately 35(mu)sec. From this total time delay, a modified **frame** is created by allowing for a period of dead time in each time **frame** , where the dead time is equal to (DELTA)(sub(total)). Continuing with this example, if (DELTA)(sub(total))=35(mu)sec., the length of time for the modified **frame** , t(sub(mf)), is equal to: (Formula omitted) CO processor 15 then determines in step...

...mu) sec. In step 630, CO processor 15 assigns each modified time slot to an **ONU** as a function of its time delay, (DELTA)(sub(i)), with the closest **ONU** being associated with the first modified time slot. In the case of equidistant ONUs, they are selected in any order. CO processor 15 then sequentially transmits each **ONU** 's information in its associated time slot as described above. As a result of compressing the time **frame** and ordering the assignment of **time slots** to ONUs in order of increasing **optical** path lengths from RN 90, the time **frame** comprising the **upstream** information will appear to CO processor 15 as shown in FIG. 8. As represented in FIG. 8, it is assumed that **ONU** 100 is closest, ONUs 200 and 300 are equidistant, followed by **ONU** 400. It can be observed from FIG. 8 that deal times, (delta)(sub(i)), are distributed throughout this received time **frame** . Each deal time, (delta)(sub(i)) is equal to the difference between the end of...

...between the end of packet 1 and the arrival of packet 2. Consequently, the returning **optical** signal will effectively have dead time between each of the packets, where the sum total...

...into the system as a result of the allowance for dead time in each time **frame** .

Another approach to avoiding packet collisions is to subcarrier modulate the packets in each time...

16/3,K/12 (Item 1 from file: 349)

DIALOG(R)File 349:PCT FULLTEXT
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00492439 **Image available**

COMMUNICATIONS NETWORK

RESEAU DE TRANSMISSION

Patent Applicant/Assignee:
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QUAYLE John Alan,
Inventor(s):
QUAYLE John Alan,

Patent and Priority Information (Country, Number, Date):
Patent: WO 9923791 A1 19990514
Application: WO 98GB3229 19981029 (PCT/WO GB9803229)
Priority Application: EP 97308857 19971104
Designated States: AL AM AT AU AZ BA BB BG BR BY CA CH CN CU CZ DE DK EE ES FI GB GD GE GH GM HR HU ID IL IS JP KE KG KP KR KZ LC LK LR LS LT LU LV

MD MG MK MN MW MX NO NZ PL PT RO RU SD SE SG SI SK SL TJ TM TR TT UA UG
US UZ VN YU ZW GH GM KE LS MW SD SZ UG ZW AM AZ BY KG KZ MD RU TJ TM AT
BE CH CY DE DK ES FI FR GB GR IE IT LU MC NL PT SE BF BJ CF CG CI CM GA
GN GW ML MR NE SN TD TG
Publication Language: English
Fulltext Word Count: 7054
Fulltext Availability:
Detailed Description

Detailed Description
... capacity is made at the time of call set-up by a user via an **ONU** so that the same number of data packets may be sent from the **ONU** to the OLT each time the **ONU** 's time slot arrives for transfer of its **upstream** data. In some **time slots** , not all the allocated capacity may be used by the ONLI, while in others the **ONU** may have more packets in its buffer than the allocation will allow to be transmitted...

16/3,K/13 (Item 2 from file: 349)
DIALOG(R)File 349:PCT FULLTEXT
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00405228 **Image available**
METHOD FOR STRUCTURING OF DIGITAL DATA WHICH CAN BE TRANSFERRED IN BOTH DIRECTIONS ON A PASSIVE OPTICAL NETWORK (PON) IN A PON TDMA SYSTEM
PROCEDE POUR STRUCTURER DES DONNEES NUMERIQUES TRANSFERABLES BIDIRECTIONNELLEMENT SUR UN RESEAU OPTIQUE PASSIF DANS UN SYSTEME AMRT A RESEAU OPTIQUE PASSIF
Patent Applicant/Assignee:
ITALTEL S P A,
PROFUMO Alberto,
D'ASCOLI Lucio,
SERIO Franco,
PODESTA' Angelo,
CASTOLDI Pierluigi,
Inventor(s):
PROFUMO Alberto,
D'ASCOLI Lucio,
SERIO Franco,
PODESTA' Angelo,
CASTOLDI Pierluigi,
Patent and Priority Information (Country, Number, Date):
Patent: WO 9745972 A2 19971204
Application: WO 97EP2717 19970523 (PCT/WO EP9702717)
Priority Application: IT 96MI1064 19960527
Designated States: CA CN CU US AT BE CH DE DK ES FI FR GB GR IE IT LU MC NL PT SE
Publication Language: English
Fulltext Word Count: 6010

Fulltext Availability:
Detailed Description
Claims

Detailed Description
... time division multiple access protocol (TDMA) characterized in that it consists.

0 defining a transmission **frame** , according to the line speed, for both the **downstream** and **upstream** transmission directions, that is from OLT towards **ONU**
and from **ONU** to OLT, respectively, having constant duration;
* each one of said **frames** consisting, in each transmission direction, of an integer number N of slots, so that a one-to-one relation between each slot forming part of the **downstream** **frame** structure and each slot forming part of the **upstream** **frame**
structure, is always valid;

0 in the **downstream** direction, each slot containing m fundamental blocks, being m an integer number higher than 1...

...between them
inside the slot, in a constant and pre-set way;
6 in the **upstream** direction, each slot consisting of a j-byte guard field, an L-byte
preamble field and of a 53-byte useful field;
* the line transmission speed in the **upstream** direction being equal or a precise sub
multiple of the **downstream** line transmission speed,
In other words, the method according to the invention consists in defining as shown in Fig. 4, a structure of fundamental **frame** having nominal duration exactly equal to 125 microseconds and a multiframe consisting of a given number k, multiple of four, of fundamental **frames** , both concerning the **downstream** transmission, that is the **optical** transmission in "broadcast" mode through the passive **optical network** (PON) from the **optical** line termination (OLT) towards a plurality of **Optical Network** Termination (**ONU**) units (symbolically the OLT---), **ONU** flow), and the **upstream** transmission, that is transmission in the opposite direction, based on a TDMA protocol.

Each fundamental...

Claim
... data, to be transferred through a same broad band PON access system, consisting of an **Optical** Line Termination or OLT and of a plurality of **Optical Network** Units or **ONU** , employing for the interconnection of said unks a passive **optical network** and operating in the direction from **ONU** to OLT,
according to a time division multiple access protocol (TDMA),
characterized in that it consists:
defining a transmission **frame** , according to the line speed, for both the **downstream** and **upstream** directions, that is from OLT towards **ONU** and from
ONU to OLT, respectively, having constant duration;
each one of said **frames** consisting, in each transmission direction, of an integer number N of slots, so that a one-to-one relation between each slot forming part of the **downstream frame** structure and each slot forming part of the **upstream frame**
structure, is always valid;
e in the **downstream** direction, each slot containing m fundamental blocks, being m an integer number higher than 1...

...arranged between them
inside the slot, in a constant and pre-set way;
in the **upstream** direction, each slot consisting of a j-byte guard field, an L-byte
preamble field and of a 53-byte useful field;
being, the transmission speed in line in the **upstream** diTection substantially equal or substantially sub-multipie of the **downstream** line transmission speed.

2 Method according to claim 1 , in which the 53-byle always...

16/3,K/14 (Item 3 from file: 349)
DIALOG(R)File 349:PCT FULLTEXT
(c) 2002 WIPO/Univentio. All rts. reserv.

00342482 **Image available**
POINT-TO-MULTIPOINT BROADBAND SERVICES DROP WITH MULTIPLE TIME SLOT RETURN CHANNEL FOR CUSTOMER PREMISES EQUIPEMENT
BRANCHEMENT D'ABONNES DE SERVICES A LARGE BANDE POINT A MULTIPOINT AVEC CANAL DE RETOUR A CRENEAUX TEMPORELS MULTIPLES POUR EQUIPEMENT DE LOCAUX CLIENTS
Patent Applicant/Assignee:
BROADBAND TECHNOLOGIES INC,

Inventor(s):
SHARPE Randall B,
LONG Thomas Joel,
Patent and Priority Information (Country, Number, Date):
Patent: WO 9624994 A1 19960815
Application: WO 96US1545 19960206 (PCT/WO US9601545)
Priority Application: US 95383984 19950206
Designated States: CA JP KR AT BE CH DE DK ES FR GB GR IE IT LU MC NL PT SE
Publication Language: English
Fulltext Word Count: 10037

Fulltext Availability:
Detailed Description

Detailed Description
... as
a Moving Pictures Experts Group (MPEG) decoder, for driving associated video equipment.

Like the **ONU** 's (**upstream**) PHY transceiver unit, the CPE resident (**downstream**) transceiver PHY unit comprises a CAP decoder which demodulates the received (16 CAP) modulated broadband data stream from the **upstream** **optical** **network** unit, and couples the recovered clock to various circuit components, including a clock divider, which...generating return channel slotted bursts, The
received data stream is coupled to an STS-1 **framer** ,, which **frames** on the received SONET **frame** and performs a bit interleaved parity (BIP8) check on the data, A count is maintained of any errors,
The STS-1 **framer** is referenced to the recovered clock and provides a receive byte clock to **downstream** signal processing components, The scrambled SONET data **frame** is coupled to an STS-1 descrambler, which descrambles the downlink signal and couples the...
...byte detector, The F1
byte detector extracts the F1 byte from the descrambled STS-1 **frame** overhead and couples the detected F1 byte to an F1 byte comparator. This comparator uses the F1 byte to control the operation of the slotted return channel,
The data **frame** is further coupled to an ATM cell payload processor, which employs pointers in the STS...in bursts that are controlled by the detected F1 byte in the downlink STS-1 **frame** ,
The time of occurrence of the transmit enable signal generated by the comparator is derived...

...Acquisition of the initial time slot may be accomplished by setting aside one of the **time** **slots** of the return channel to initial time slot contention, using, for example, an Aloha contention...

...acquires
a time slot,, then that assigned time slot may by used to request additional **time** **slots** as necessary. The multidrop communication mechanism of the present invention is flexible enough to accommodate...
...may be employed to interface
the unshielded twisted pair of the multidrop link from the **optical** **network** unit with telephony and cable television signalling ports typically provided at a customer premise. The frequency diversity diplexer has a first **upstream** port to which the UTP from the **optical** **network** unit is connected, and a second **upstream** port to which coaxial cable used by a cable television service provider to deliver analog cable television signals to the customer premise is connected, The diplexer also includes a first **downstream** , telephony signalling port to which a twisted pair for customer premises telephone equipment

may be connected, It additional includes a second **downstream** ,
coaxial cable port to which a television set top box or
standard cable-ready television...
?

```
File   2:INSPEC 1969-2002/Apr W3
         (c) 2002 Institution of Electrical Engineers
File   6:NTIS 1964-2002/May W1
         (c) 2002 NTIS, Intl Cpyrght All Rights Res
File   8:Ei Compendex(R) 1970-2002/Apr W3
         (c) 2002 Engineering Info. Inc.
File  34:SciSearch(R) Cited Ref Sci 1990-2002/Apr W4
         (c) 2002 Inst for Sci Info
File  35:Dissertation Abs Online 1861-2002/Apr
         (c) 2002 ProQuest Info&Learning
File  65:Inside Conferences 1993-2002/Apr W3
         (c) 2002 BLDSC all rts. reserv.
File  77:Conference Papers Index 1973-2002/Mar
         (c) 2002 Cambridge Sci Abs
File  99:Wilson Appl. Sci & Tech Abs 1983-2002/Mar
         (c) 2002 The HW Wilson Co.
File 144:Pascal 1973-2002/Apr W3
         (c) 2002 INIST/CNRS
File 238:Abs. in New Tech & Eng. 1981-2002/Apr
         (c) 2002 Reed-Elsevier (UK) Ltd.
File 434:SciSearch(R) Cited Ref Sci 1974-1989/Dec
         (c) 1998 Inst for Sci Info
File 108:AEROSPACE DATABASE 1962-2002/APR
         (c) 2002 AIAA
File 583:Gale Group Globalbase(TM) 1986-2002/Apr 26
         (c) 2002 The Gale Group

Set     Items   Description
S1          8   ETHERNET()PASSIVE()OPTICAL?()NETWORK?
S2       4718   EPON??
S3     764737   FRAME?
S4         23   (S1 OR S2) AND S3
S5         12   S4 NOT PY=>2000
S6         12   RD S5 (unique items)
S7         10   S6 NOT POWER()PLANT?
S8          3   S7 NOT (RESIN OR METAL? OR EMULSION OR EPONTE OR KINETICS -
             OR CAPILLARIES)
S9          3   RD S8 (unique items)
S10         0   S1 NOT PY=>2000
S11        80   ETHERNET AND PASSIVE AND OPTICAL? AND NETWORK?
S12        12   S11 AND FRAME?
S13         1   S12 NOT PY=>2000
S14        16   ONU AND FRAME? AND OPTICAL? AND NETWORK?
S15        12   S14 NOT PY=>2000
S16        12   S15 NOT (S4 OR S12)
S17         9   RD S16 (unique items)
S18    187084   DOWNSTREAM? OR UPSTREAM? OR (DOWN OR UP)()STREAM?
S19        41   S18 AND ONU
S20        29   S19 NOT PY=>2000
S21        25   S20 NOT (S4 OR S12 OR S14)
S22        20   RD S21 (unique items)
S23         0   ONU AND SPECIFIC AND TIME()SLOTS
S24         4   ONU AND TIME()SLOTS
S25         4   (EPON OR EPONS OR ONU) AND TIME(5N)SLOTS
S26         1   S25 NOT (S20 OR S4 OR S12 OR S14)
S27         1   S11 AND TIME(5N)SLOT?
S28         1   S27 NOT (S25 OR S20 OR S4 OR S12 OR S14)
S29      7287   AU=(KUO J? OR KUO, J? OR GRUIA D? OR GRUIA, D? OR KRAMER G?
             OR KRAMER, G? OR PESAVENTO G? OR PESAVENTO, G?)
S30        20   ALLOPTIC?
S31         2   CO="ALLOPTIC"
S32      7307   S29 OR S30 OR S31
S33       131   S32 AND (S1 OR S2 OR S3 OR S11)
S34       106   S33 NOT PY=>2000
S35       106   S34 NOT (S26 OR S20 OR S4 OR S12 OR S14)
S36        71   RD S35 (unique items)
S37        39   S36 NOT (LEPTONIC OR DECAYS OR SCATTERING OR HERA OR JET OR
            CHEMICAL? OR SALTS OR DECAY)
```

S38 23 S37 NOT (ANNIHILATION OR PION OR JETS OR POSITRON OR WATER OR GAMMA OR NONLEPTONIC OR ANTARTICA OR KRILL OR COLI OR FAMILY OR INDIVIDUALS OR ZEOLITES OF KAPPA? OR DOGS OR JET OR WORKERS OR HAIR OR XENON OR GRAVITY)

1/3,K/1 (Item 1 from file: 2)
DIALOG(R)File 2:INSPEC
(c) 2002 Institution of Electrical Engineers. All rts. reserv.

7187261 INSPEC Abstract Number: B2002-03-6210L-179, C2002-03-5620L-042
Title: Ethernet passive optical network **(EPON): building a next-generation optical access network**
Author(s): Kramer, G.; Pesavento, G.
Author Affiliation: Alloptic Inc., Livermore, CA, USA
Journal: IEEE Communications Magazine vol.40, no.2 p.66-73
Publisher: IEEE,
Publication Date: Feb. 2002 Country of Publication: USA
CODEN: ICOMD9 ISSN: 0163-6804
SICI: 0163-6804(200202)40:2L.66:EPON;1-M
Material Identity Number: I318-2002-002
U.S. Copyright Clearance Center Code: 0163-6804/02/$17.00
Language: English
Subfile: B C
Copyright 2002, IEE

Title: Ethernet passive optical network **(EPON): building a next-generation optical access network**
Abstract: This article describes **Ethernet passive optical networks** , an emerging local subscriber access architecture that combines low-cost point-to-multipoint fiber infrastructure...
Identifiers: **Ethernet passive optical networks** ;

1/3,K/2 (Item 1 from file: 8)
DIALOG(R)File 8:Ei Compendex(R)
(c) 2002 Engineering Info. Inc. All rts. reserv.

06019822 E.I. No: EIP02116887869
Title: IPACT: A dynamic protocol for an Ethernet PON (EPON)
Author: Kramer, Glen; Mukherjee, Biswanath; Pesavento, Gerry
Corporate Source: Advanced Technology Laboratory Alloptic, Inc., Livermore, CA, United States
Source: IEEE Communications Magazine v 40 n 2 February 2002. p 74-80
Publication Year: 2002
CODEN: ICOMD9 ISSN: 0163-6804
Language: English

Identifiers: Interleaved polling algorithm; **Ethernet passive optical networks** ; Dynamic bandwidth distribution; Single downstream wavelength; Single upstream wavelength; Control message transmission; Synthetic traffic

1/3,K/3 (Item 2 from file: 8)
DIALOG(R)File 8:Ei Compendex(R)
(c) 2002 Engineering Info. Inc. All rts. reserv.

06019821 E.I. No: EIP02116887868
Title: Ethernet passive optical network **(EPON): Building a next-generation optical access network**
Author: Kramer, Glen; Pesavento, Gerry
Corporate Source: Advanced Technology Lab. Alloptic, Inc., Livermore, CA, United States
Source: IEEE Communications Magazine v 40 n 2 February 2002. p 66-73
Publication Year: 2002
CODEN: ICOMD9 ISSN: 0163-6804
Language: English

Title: Ethernet passive optical network **(EPON): Building a next-generation optical access network**
Abstract: This article describes **Ethernet passive optical networks** , an emerging local subscriber access architecture that combines low-cost point-to-multipoint fiber infrastructure...
Identifiers: **Ethernet passive optical network** ; Optical access

network; Point to multipoint fiber; Internet protocol traffic; Fiber to the building; Fiber...

1/3,K/4 (Item 1 from file: 34)
DIALOG(R)File 34:SciSearch(R) Cited Ref Sci
(c) 2002 Inst for Sci Info. All rts. reserv.

10365318 Genuine Article#: 518PD No. References: 9
Title: Ethernet passive optical network **(EPON): Building a next-generation optical access network**
Author(s): Kramer G; Pesavento G
Journal: IEEE COMMUNICATIONS MAGAZINE, 2002, V40, N2 (FEB), P66-73
ISSN: 0163-6804 Publication date: 20020200
Publisher: IEEE-INST ELECTRICAL ELECTRONICS ENGINEERS INC, 345 E 47TH ST, NEW YORK, NY 10017-2394 USA
Language: English Document Type: ARTICLE (ABSTRACT AVAILABLE)

Title: Ethernet passive optical network **(EPON): Building a next-generation optical access network**
Abstract: This article describes **Ethernet passive optical networks** , an emerging local subscriber access architecture that combines low-cost point-to-multipoint fiber infrastructure...

1/3,K/5 (Item 1 from file: 65)
DIALOG(R)File 65:Inside Conferences
(c) 2002 BLDSC all rts. reserv. All rts. reserv.

03757649 INSIDE CONFERENCE ITEM ID: CN039506762
Gigabit Ethernet Passive Optical Networks
Pesavento, G.; Kelsey, M.
CONFERENCE: Gigabit ethernet conference
GIGABIT ETHERNET CONFERENCE, 2001 P: 65-76
Gigabit ethernet conference, 2001
LANGUAGE: English DOCUMENT TYPE: Conference Papers and presentations
CONFERENCE LOCATION: San Jose, CA 2001; Apr (200104) (200104)

Gigabit Ethernet Passive Optical Networks

1/3,K/6 (Item 1 from file: 99)
DIALOG(R)File 99:Wilson Appl. Sci & Tech Abs
(c) 2002 The HW Wilson Co. All rts. reserv.

2413303 H.W. WILSON RECORD NUMBER: BAST02105353
Ethernet passive optical network **(EPON): building a next-generation optical access network**
Kramer, Glen; Pesavento, Gerry
IEEE Communications Magazine v. 40 no2 (Feb. 2002) p. 66-73
DOCUMENT TYPE: Feature Article ISSN: 0163-6804

Ethernet passive optical network **(EPON): building a next-generation optical access network**

1/3,K/7 (Item 1 from file: 144)
DIALOG(R)File 144:Pascal
(c) 2002 INIST/CNRS. All rts. reserv.

15454688 PASCAL No.: 02-0147606
IPACT: A dynamic protocol for an Ethernet PON (EPON)
KRAMER G; MUKHERJEE B; PESAVENTO G
Advanced Technology Laboratory Alloptic, Inc., Livermore, CA, United States
Journal: IEEE Communications Magazine, 2002, 40 (2) 74-80
Language: English

English Descriptors: Interleaved polling algorithm; **Ethernet passive optical networks** ; Dynamic bandwidth distribution; Single downstream wavelength; Single upstream wavelength; Control message transmission; Synthetic traffic; Application...

1/3,K/8 (Item 2 from file: 144)
DIALOG(R)File 144:Pascal
(c) 2002 INIST/CNRS. All rts. reserv.

15454687 PASCAL No.: 02-0147605
Ethernet passive optical network **(EPON): Building a next-generation optical access network**
KRAMER G; PESAVENTO G
Advanced Technology Lab. Alloptic, Inc., Livermore, CA, United States
Journal: IEEE Communications Magazine, 2002, 40 (2) 66-73
Language: English

Ethernet passive optical network **(EPON): Building a next-generation optical access network**
This article describes **Ethernet passive optical networks** , an emerging local subscriber access architecture that combines low-cost point-to-multipoint fiber infrastructure...

English Descriptors: **Ethernet passive optical network** ; Optical access network; Point to multipoint fiber; Internet protocol traffic; Fiber to the building; Fiber...
?

9/3,K/1 (Item 1 from file: 2)
DIALOG(R)File 2:INSPEC
(c) 2002 Institution of Electrical Engineers. All rts. reserv.

04261547 INSPEC Abstract Number: B9212-8230G-001
Title: 227-MW Frame **9FA will power** EPON **'s 1.7-GW combined cycle**
Author(s): Farmer, R.
Journal: Gas Turbine World vol.22, no.3 p.15, 17-18, 20-1, 23-4
Publication Date: May-June 1992 Country of Publication: USA
CODEN: GTWODG ISSN: 0746-4134
Language: English
Subfile: B

Title: 227-MW Frame **9FA will power** EPON **'s 1.7-GW combined cycle**
...Identifiers: **Frame** 9FA

9/3,K/2 (Item 1 from file: 8)
DIALOG(R)File 8:Ei Compendex(R)
(c) 2002 Engineering Info. Inc. All rts. reserv.

05135956 E.I. No: EIP98104417920
Title: Strain in isotropic pin-joints: Experimental and numerical analysis
Author: di Scalea, F. Lanza
Corporate Source: Johns Hopkins Univ, Baltimore, MD, USA
Source: Experimental Techniques v 22 n 5 Sep-Oct 1998. p 25-27
Publication Year: 1998
CODEN: EXPTD2 ISSN: 0732-8818
Language: English

...Abstract: speckle pattern interferometer was used to determine the displacement field and strain distributions in an **Epon** 828 epoxy plate loaded in tension through a steel pin. The in-plane displacement map...

...quickly, and had a spatial resolution of the order of a few pixels in the **frame** grabber system. The least-square fitting of the displacement data allowed strain calculation with an...

9/3,K/3 (Item 1 from file: 144)
DIALOG(R)File 144:Pascal
(c) 2002 INIST/CNRS. All rts. reserv.

12253412 PASCAL No.: 95-0478617
Phase equilibria of balanced microemulsions
DAICIC J; OLSSON U; WENNERSTROEM H
Univ. Lund, 1 chemical cent., div. physical chemistry 1, 221 00 Lund, Sweden
Journal: Langmuir, 1995, 11 (7) 2451-2458
Language: English

The flexible surface model is a powerful **framework** in which to describe the thermodynamics of fluid membrane phases. In the case of balanced...

...French Descriptors: non ionique; Ethylene oxyde polymere; Hydrocarbure; Decane; Compose sature; Compose aliphatique; Eau; Structure lamellaire; Phase **eponge**
?

13/3,K/1 (Item 1 from file: 2)
DIALOG(R)File 2:INSPEC
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04075527 INSPEC Abstract Number: B9203-6210L-016, C9203-5620L-011
Title: Prioritized acknowledgement delivery using intentional collision scheme in CSMA/CD-based packet networks
Author(s): Oguchi, K.; Hakamata, Y.
Author Affiliation: NTT Transmission Syst. Labs., Yokosuka, Japan
Journal: IEICE Transactions vol.E74, no.9 p.2712-20
Publication Date: Sept. 1991 Country of Publication: Japan
CODEN: IEITEF ISSN: 0917-1673
Language: English
Subfile: B C

Title: Prioritized acknowledgement delivery using intentional collision scheme in CSMA/CD-based packet networks
...Abstract: highest transmission priority to ACK delivery so as to enable higher ACK transmission speeds in **networks** using the carrier sense multiple access with collision detection (CSMA/CD) access procedure. This scheme...

... been received at the source adapter when a packet collision is observed after the end **frame** delimiter (EFD) of the return-packet. The throughput of a non-persistent CSMA/CD using the new scheme is then analyzed. This throughput is compared to the previously-proposed Acknowledge **Ethernet** type scheme. The analysis indicates that the new scheme yields a throughput several percent higher than the previous one. Application of the scheme to a 32 Mbit/s fiber-optic **passive** star **network** , or SOLARnet, is outlined. The experimental results obtained in a SOLARnet field trial are also...
...Descriptors: local area **networks** ; ...

... **optical** fibres...

... **optical** links
...Identifiers: CSMA/CD-based packet **networks** ; ...

...end **frame** delimiter...

...fiber-optic **passive** star **network** ;

17/3,K/1 (Item 1 from file: 2)
DIALOG(R)File 2:INSPEC
(c) 2002 Institution of Electrical Engineers. All rts. reserv.

6753996 INSPEC Abstract Number: B2000-12-6150M-055
Title: Efficient support of TCP/IP traffic on superPON
Author(s): Kristiaan, V.; Rudy, H.
Author Affiliation: Alcatel Corp. Res. Center, Antwerp, Belgium
Conference Title: Proceedings Broadband Access Conference. BAC'99 p. 246-54
Editor(s): Pach, A.R.; Papir, Z.
Publisher: Fundacji Postepu Telekomunikacji, Cracow, Poland
Publication Date: 1999 Country of Publication: Poland v+260 pp.
ISBN: 83 86476 27 3 Material Identity Number: XX-1999-03071
Conference Title: Proceedings of BAC'99: Broadband Access Conference
Conference Sponsor: IEEE Poland Sect.; Cracow Commun. Soc.; ZWUT S.A.; ALcatel; Telekomunikacja Polska S.A.; Lucent Technol
Conference Date: 11-13 Oct. 1999 Conference Location: Cracow, Poland
Language: English
Subfile: B
Copyright 2000, IEE

...Abstract: of Internet traffic, and in particular TCP/IP, the medium access control (MAC) of passive **optical** access **networks** must also take into account also the characteristics of the IP traffic. The guaranteed **frame** rate (GFR) service category that was proposed in the ATM Forum, is a possible carrier...

...the dynamic MAC protocol together with intelligent buffer acceptance and cell scheduling mechanisms on the **ONU** are capable of fulfilling these requirements. They provide bandwidth and fairness guarantees to the GFR...
...Descriptors: **optical** fibre **networks** ;
...Identifiers: passive **optical** access **networks** ; ...

...guaranteed **frame** rate...

... **ONU** ;

17/3,K/2 (Item 2 from file: 2)
DIALOG(R)File 2:INSPEC
(c) 2002 Institution of Electrical Engineers. All rts. reserv.

6300157 INSPEC Abstract Number: B1999-08-6260F-039
Title: Design of the MAC frame **structure regardless of contention in ATM-PON**
Author(s): Nam Jae-Hyun; Jang Jong-Wook; Lee Jung-Tae
Author Affiliation: Dong-ju Woman's Junior Coll., Pusan, South Korea
Conference Title: ICCT'98. 1998 International Conference on Communication Technology. Proceedings (IEEE Cat. No.98EX243) Part vol.2 p.5 pp. vol.2
Editor(s): Chunpei, X.
Publisher: Publising House of Constr. Mater, Beijing, China
Publication Date: 1998 Country of Publication: China 2 vol.787+832 pp.
ISBN: 7 80090 827 5 Material Identity Number: XX-1998-03567
Conference Title: ICCT'98. 1998 International Conference on Communication Technology. Proceedings
Conference Sponsor: China Inst Commun. (CIC); Chinese Inst. Electron. (CIE); IEEE Commun. Soc. (IEEE COMSOC)
Conference Date: 22-24 Oct. 1998 Conference Location: Beijing, China
Language: English
Subfile: B
Copyright 1999, IEE
Title: Design of the MAC frame **structure regardless of contention in ATM-PON**
...Abstract: the world-wide market for the product. Multiplexing of data from the customer into the **network** is done passively on the PON. PONs

offer a flexible future proof service delivery platform for the access **network** . The MAC (medium access control) protocol controls **ONU** (**optical** **network** unit) access to the shared capacity on the PON, this protocol is very important if...

... been proposed and are now proposed. Therefore there are many kinds of protocol and data **frame** that are transmitted between OLT (**optical** line termination) and ONUs. If the **network** operator which manages OLT supports many types of protocol at ONUs, the **network** operator can support these. In this paper, the MAC **frame** structure offers the flexibility to cope with different physical layer specifications. At the same time...

... variety of media access protocols so that a variety of services can be supported. This **frame** guarantees the operation of various protocols at ONUs using a key-set that has variable...
...Descriptors: broadband **networks** ; ...

... **optical** fibre subscriber loops
Identifiers: MAC **frame** structure...

...access **network** ; ...

... **optical** **network** unit...

...data **frame** ; ...

...passive **optical** **networks**

17/3,K/3 **(Item 3 from file: 2)**
DIALOG(R)File 2:INSPEC
(c) 2002 Institution of Electrical Engineers. All rts. reserv.

5498698 INSPEC Abstract Number: B9703-6260-224
Title: Customer ONU : **cost and technology and standardisation issues**
Author(s): Zylbersztejn, A.; Baker, R.; Di Biase, V.; De Blok, K.; Bouley, J.C.; Chiaretti, G.; Cocito, M.; Destefanis, G.; Dudley, T.; Imai, H.; Jacobs, B.; Kaede, K.; Lecrosnier, D.; Mesquida, G.; Oliver, S.; Robertson, M.; Rogers, K.; Roth, P.; Schwaderer, B.; Turley, S.; Yoshida, J.
Author Affiliation: CNET, France
Journal: CSELT Technical Reports vol.24, no.5 p.817-28
Publisher: CSELT,
Publication Date: Oct. 1996 Country of Publication: Italy
CODEN: CTRPEJ ISSN: 0393-2648
SICI: 0393-2648(199610)24:5L.817:CCTS;1-K
Material Identity Number: I648-97001
Language: Italian; English
Subfile: B
Copyright 1997, IEE

Title: Customer ONU : **cost and technology and standardisation issues**
Abstract: The paper analyses the cost factors for the customer **optical** **network** unit (**ONU**) for fibre to the home (FTTH). It is shown that present micro-optics technology cannot yield a low enough price for the **optical** module. The advantages of large volume production will become a reality through the implementation of...

... breakthroughs in hybrid integration. It is shown that a target price of 125$ for the **ONU** is realistic in a two years time **frame** , for a production of one million parts per year. The standardisation of the **ONU** parameters, which must be addressed in order to bring this potential to full realisation, are...
...Descriptors: **optical** communication equipment...

... **optical** fibre subscriber loops
Identifiers: customer **ONU** ; ...

...customer **optical** **network** unit...

... **optical** module

17/3,K/4 (Item 4 from file: 2)
DIALOG(R)File 2:INSPEC
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5072428 INSPEC Abstract Number: B9511-6150M-034, C9511-5640-033
Title: Time division multiple access protocol for a fiber-optic passive double star transport system
Author(s): Miki, N.; Kumozaki, K.
Author Affiliation: Dept. of Dev., NTT Network Syst., Chiba, Japan
Journal: IEICE Transactions on Communications vol.E78-B, no.7 p. 995-1001
Publication Date: July 1995 Country of Publication: Japan
CODEN: ITCMEZ ISSN: 0916-8516
Language: English
Subfile: B C
Copyright 1995, IEE

...Abstract: is calculated and compared to fixed time slot multiplexing for telephony services. A TCM/TDMA **frame** structure and an access protocol enabling dynamic time slot multiplexing are proposed. **ONU** bandwidth is dynamically assigned by using a set of pointers. The **ONU** access protocol causes no interruption to operating ONUs on the same PDS system during the configuration or reconfiguration of an **ONU** . The access time is analyzed to estimate the performance of the access protocol. The probability...
...Descriptors: computer **networks** ; ...

... **optical** fibre subscriber loops
...Identifiers: TCM/TDMA **frame** structure...

... **ONU** access protocol...

...fiber optic access **network** ; ...

... **optical** **network** unit

17/3,K/5 (Item 5 from file: 2)
DIALOG(R)File 2:INSPEC
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5043540 INSPEC Abstract Number: B9510-6220B-046
Title: From ISDN to ATM: fibre in the loop, an evolving scenario
Author(s): Abiven, J.; Bourgart, F.; Le Goff, Y.
Author Affiliation: CNET France Telecom, Lannion, France
Conference Title: 5th Conference on Optical/Hybrid Access Networks. Conference Proceedings (Cat. No.93TH0542-1) p.6.03/01-6
Publisher: IEEE, New York, NY, USA
Publication Date: 1992 Country of Publication: USA 338 pp.
ISBN: 0 7803 1249 X
Conference Title: Proceedings of 5th Conference on Optical Hybrid Access Networks
Conference Date: 7-9 Sept. 1993 Conference Location: Montreal, Que., Canada
Language: English
Subfile: B
Copyright 1995, IEE

Abstract: Compatibility between several different **optical** transmission techniques is revealed, provided that the **frame** structure and system equipment are specified according to various organizational constraints. Standardization can proceed without...
... the time compression multiplex (TCM). Similarly, by judiciously organizing exchange equipment (OLT) and user equipment (**ONU**) functions,

network interfaces and **optical** transmission can evolve separately and broadband services can be accommodated progressively. The multispeed **frame** principle remains the cornerstone of the system given its suitability for matching equipment to applications...

... affords a high degree of openness in the definition of specifications. Economic parity of the **optical** systems in fiber-to-the-home (FTTH) distribution is contingent on the development of new and integrated **optical** components.
...Descriptors: **optical** communication equipment...

... **optical** fibre subscriber loops
...Identifiers: **optical** transmission techniques...

... **frame** structure...

... **network** interfaces...

...integrated **optical** components

17/3,K/6 (Item 6 from file: 2)
DIALOG(R)File 2:INSPEC
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04055728 INSPEC Abstract Number: B9202-6260-304
Title: A new concept for passive optical networks **(multi bit rate** optical **transmission system)**
Author(s): Abiven, J.; Bourgart, F.
Author Affiliation: France Telecom, CNET, Lannion, France
Conference Title: EFOC/LAN 91. Papers Presented at: The Ninth Annual European Fibre Optic Communications and Local Area Network Conference. EFOC Proceedings p.348-52
Publisher: IGI Europe, Boston, MA, USA
Publication Date: 1991 Country of Publication: USA xxivv+525 pp.
ISBN: 3 905084 01 5
Conference Date: 19-21 June 1991 Conference Location: London, UK
Language: English
Subfile: B

Title: A new concept for passive optical networks **(multi bit rate** optical **transmission system)**
Abstract: One of the most important limits of passive **optical networks** concerns the evolution from POTS or narrowband services towards broadband services. The authors propose a new concept based on a multi-bit rate transmission system. Due to this concept, the **frame** is divided into predetermined parts and the instantaneous bit rate inside each part is related...

... service provided to each subscriber. This concept allows an economical optimization of low bit rate **network** terminals (**ONU**) without having to take into account the needs for further evolution. The ONUs are developed ...
...Descriptors: **optical** links
...Identifiers: local **network** ; ...

...passive **optical networks** ; ...

...low bit rate **network** terminals

17/3,K/7 (Item 1 from file: 8)
DIALOG(R)File 8:Ei Compendex(R)
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05443256 E.I. No: EIP99124945911
Title: Dynamic bandwidth allocation on SuperPON
Author: Hoebeke, Rudy; Venken, Kristiaan; Stojanovski, Saso

Corporate Source: Alcatel Corporate Research Cent, Antwerp, Belgium
Conference Title: Proceedings of the All-Optical Networking 1999: Architecture, Control, and Management Issues
Conference Location: Boston, MA, USA Conference Date: 19990919-19990921
E.I. Conference No.: 56064
Source: Proceedings of SPIE - The International Society for Optical Engineering v 3843 1999. p 207-215
Publication Year: 1999
CODEN: PSISDG ISSN: 0277-786X
Language: English

Abstract: Currently, the first FSAN compliant ATM-based Passive **Optical Networks** (APON) are installed in the field. A possible evolution scenario for these types of access **networks** could be the so-called SuperPON system. The SuperPON system exploits all possible upgrades of...

...since the upstream bit rate is rather limited for such a large number of connected **Optical Network** Units (**ONU**). Main challenges specific to the SuperPON are the impact of long range and high number...

...the proposed MAC protocol, we focus on the support of TCP over the ATM Guaranteed **Frame** Rate (GFR) service. GFR has been proposed in the ATM Forum as an enhancement to...

...conventional best-effort UBR service category. It provides a MCR guarantee to VCs at the **frame** level, along with an opportunity to fairly use any additional bandwidth left over from higher...

...current internetworking applications. It will be shown that the SuperPON MAC protocol developed in the **framework** of the ACTS project PELICAN yields very good performance for a wide range of traffic...
Descriptors: Fiber optic **networks** ; **Optical** communication; Bandwidth; Frequency allocation; Asynchronous transfer mode; **Optical** beam splitters; **Network** protocols; Telecommunication traffic; Congestion control (communication); Telecommunication services
Identifiers: Passive **optical networks** (PON); Medium access control (MAC) protocol; Transmission control protocol/Internet protocol (TCP/IP); Guaranteed **frame** rate (GFR) services

17/3,K/8 (Item 2 from file: 8)
DIALOG(R)File 8:Ei Compendex(R)
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04651416 E.I. No: EIP97033577072
Title: L' ONU di utente: costo tecnologia e problemi di standardizzazione
Title: Customer **ONU** : cost and technology and standardisation issues
Author: Zylbersztejn, A.; Baker, R.; Di Biase, V.; de Blok, K.; Bouley, J.C.; Chiaretti, G.; Cocito, M.; Destefanis, G.; Dudley, T.; Imai, H.; Jacobs, B.; Kaede, K.; Lecrosnier, D.; Mesquida, G.; Oliver, S.; et al
Corporate Source: CSELT
Source: CSELT Technical Reports (Centro Studi e Laboratori Telecomunicazioni) v 24 n 5 Oct 1996. p 817-828
Publication Year: 1996
CODEN: CTRPEJ
Language: English; Italian

Title: L' ONU di utente: costo tecnologia e problemi di standardizzazione
Title: Customer **ONU** : cost and technology and standardisation issues
Abstract: The paper analyses the cost factors for the customer **Optical Network** Unit (**ONU**) for Fibre to the home (FTTH). It is shown that present micro-optics technology cannot yield a low enough price for the **optical** module. The advantages of large volume production will become a reality through the implementation of...

...in hybrid integration. It is shown that a target price of 125 dollar for

the **ONU** is realistic in a two years time **frame** , for a production of one million parts per year. The standardisation of the **ONU** parameters, which must be addressed in order to bring this potential to full realisation, are ...
Descriptors: Fiber optic **networks** ; Telecommunication **networks** ; Cost effectiveness; Standardization; Technology; Optics
Identifiers: **Optical network** unit; Fiber to the home

17/3,K/9 (Item 1 from file: 34)
DIALOG(R)File 34:SciSearch(R) Cited Ref Sci
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05404368 Genuine Article#: VW570 No. References: 18
Title: ARRAYED-WAVE-GUIDE GRATING LASERS AND THEIR APPLICATIONS TO TUNING-FREE WAVELENGTH ROUTING
Author(s): TACHIKAWA Y; OKAMOTO K
Corporate Source: NIPPON TELEGRAPH & TEL PUBL CORP,OPTOELECT LABS/TOKAI/IBARAKI 31911/JAPAN/
Journal: IEE PROCEEDINGS-OPTOELECTRONICS, 1996, V143, N5 (OCT), P322-328
ISSN: 1350-2433
Language: ENGLISH Document Type: ARTICLE (Abstract Available)

...Abstract: the useful application of the tunable AWG laser source for dense wavelength division multiplexing (WDM) **networks** , a new lightwave transrouter (LTR) is constructed using the AWG multiplexer formed of an appropriate...

...of the principle tuning-free mechanism. Additionally, a reflective modulator is introduced into a sourceless **optical network** unit (**ONU**) for WDM passive **optical networks** (PONs) and then its fine-signal response is obtained.
...Identifiers--MULTIPLEXER; **NETWORKS**
Research Fronts: 94-0577 001 (ARRAYED-WAVE-GUIDE GRATING MULTIPLEXER; **OPTICAL** AMPLIFIER; WDM SYSTEMS)
94-7029 001 (**OPTICAL** WAVE-GUIDE FOR AUTOMATED **OPTICAL** MAIN-DISTRIBUTING- **FRAME** SYSTEM; SILICA-BASED PLANAR LIGHTWAVE CIRCUITS)

22/3,K/1 (Item 1 from file: 2)
DIALOG(R)File 2:INSPEC
(c) 2002 Institution of Electrical Engineers. All rts. reserv.

6622382 INSPEC Abstract Number: B2000-07-6260F-025
Title: ONU **component for DWDM upgrading of FTTx access network**
Author(s): Buldawoo, N.; Mottet, S.; Gadonna, M.; Dupont, H.
Author Affiliation: France Telecom, CNET, Lannion, France
Conference Title: 25th European Conference on Optical Communication. ECOC '99 Conference Part vol.1 p.346-7 vol.1
Publisher: Soc. Electr. Electron, Paris, France
Publication Date: 1999 Country of Publication: France 2 vol.(xxxiii+463+322+65 suppl) pp.
ISBN: 2 912328 12 8 Material Identity Number: XX-1999-03183
Conference Title: Proceedings of ECOC'99. 25th European Conference on Optical Communication
Conference Sponsor: Minstr. Educ. Nat.; Minstr. Econ. Finances et de Ind
Conference Date: 26-30 Sept. 1999 Conference Location: Nice, France
Language: English
Subfile: B
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Title: ONU **component for DWDM upgrading of FTTx access network**
...Abstract: ATM PON solutions. The splitting ratio together with time division multiplexing protocol limit the available **downstream** bit rate at the **ONU** . Dense WDM passive optical networks are an upgrading solution for FSAN FTTx. One of the difficulties could be the **ONU** optoelectronic component. For this, we have investigated the use of a single semiconductor laser amplifier/reflector at the **ONU** in order to avoid the generation of a specific wavelength. In this paper the **downstream** detection function up to 1.5 Gb/s and the **upstream** reflection-mode operation at 155 Mb/s are demonstrated.
Identifiers: **ONU** component...

... **downstream** bit rate...

... **ONU** optoelectronic component...

... **downstream** detection function...

... **upstream** reflection-mode operation

22/3,K/2 (Item 2 from file: 2)
DIALOG(R)File 2:INSPEC
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6537148 INSPEC Abstract Number: B2000-04-1210-024
Title: Low power CMOS burst-mode laser driver for full service access network application
Author(s): Sackinger, E.; Ota, Y.; Gabara, T.J.; Fischer, W.C.
Author Affiliation: Lucent Technols., Bell Labs., Holmdel, NJ, USA
Conference Title: Technical Digest. CLEO/Pacific Rim '99. Pacific Rim Conference on Lasers and Electro-Optics (Cat. No.99TH8464) Part vol.2 p.519-20 vol.2
Publisher: IEEE, Piscataway, NJ, USA
Publication Date: 1999 Country of Publication: USA 4 vol. xii+1335 pp.
ISBN: 0 7803 5661 6 Material Identity Number: XX-1999-03353
U.S. Copyright Clearance Center Code: 0 7803 5661 6/99/$10.00
Conference Title: Technical Digest. CLEO/Pacific Rim '99
Conference Sponsor: Opt. Soc. Korea; IEEE/Lasers & Electro-Opt. Soc.; Opt. Soc. America; Japan Soc. Appl. Phys.; IEICE; Korean Opt. Manuf. Assoc. ; COEX(Convention & Exhibition), Seoul
Conference Date: 30 Aug.-3 Sept. 1999 Conference Location: Seoul, South Korea
Language: English
Subfile: B

Copyright 2000, IEE

...Abstract: as full service access network (FSAN) require special burst-mode transmitters and receivers for the **upstream** direction (from the subscriber to the central office). This is necessary because multiple subscribers share...

... PON system is the burst-mode transmitter which is located inside the optical network unit (**ONU**) at the subscriber end. It must be low in power consumption since it must run...
...Identifiers: **upstream** direction

22/3,K/3 (Item 3 from file: 2)
DIALOG(R)File 2:INSPEC
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6463181 INSPEC Abstract Number: B2000-02-6260C-036
Title: Delivery of digital video and other multimedia services (>1 Gb/s bandwidth) in passband above the 155 Mb/s baseband services on a FTTx full service access network
Author(s): Chand, N.; Magill, P.D.; Swaminathan, S.V.; Daugherty, T.H.
Author Affiliation: AT&T Bell Labs., Murray Hill, NJ, USA
Journal: Journal of Lightwave Technology vol.17, no.12 p.2449-60
Publisher: IEEE,
Publication Date: Dec. 1999 Country of Publication: USA
CODEN: JLTEDG ISSN: 0733-8724
SICI: 0733-8724(199912)17:12L.2449:DDVO;1-R
Material Identity Number: E771-2000-001
U.S. Copyright Clearance Center Code: 0733-8724/99/$10.00
Language: English
Subfile: B
Copyright 2000, IEE

Abstract: For low cost passive optical access networks (PON), we have studied the **downstream** delivery of an additional >1 Gb/s in the passband above the 155 Mb/s...
... switched multimedia services, i.e., digital video, data, and audio. For switched services, the baseband **upstream** will be the return path. Furthermore, the passband can be used to provide a dedicated...

...a 155 Mb/s baseband system, and is compatible with baseband only optical network unit (**ONU**). We multiplexed a 155.52 Mb/s baseband signal with quadrature phase shift keying (QPSK...
...Identifiers: **downstream** delivery...

...baseband **upstream** ;

22/3,K/4 (Item 4 from file: 2)
DIALOG(R)File 2:INSPEC
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6343799 INSPEC Abstract Number: B1999-10-6260F-032
Title: Delivery of >1 Gb/s (digital video, data, and audio) downstream **in passband above the 155-Mb/s baseband services on a FTTx full service access network**
Author(s): Chand, N.; Magill, P.; Swaminathan, V.; Daugherty, T.H.
Author Affiliation: Bell Labs., Lucent Technol., Murray Hill, NJ, USA
Journal: IEEE Photonics Technology Letters vol.11, no.9 p.1192-4
Publisher: IEEE,
Publication Date: Sept. 1999 Country of Publication: USA
CODEN: IPTLEL ISSN: 1041-1135
SICI: 1041-1135(199909)11:9L.1192:DDVD;1-Q
Material Identity Number: M857-1999-009
U.S. Copyright Clearance Center Code: 1041-1135/99/$10.00
Language: English
Subfile: B

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Title: Delivery of >1 Gb/s (digital video, data, and audio) downstream **in passband above the 155-Mb/s baseband services on a FTTx full service access...**

Abstract: For low-cost passive optical access networks (PON), we have studied the **downstream** delivery of an additional >1 Gb/s in the passband above the 155-Mb/s...

...a 155-Mb/s baseband system, and is compatible with baseband only optical network unit (**ONU**). We multiplexed a 155.52-Mb/s baseband signal with QPSK modulated passband>1.2...

...Identifiers: **downstream** delivery

22/3,K/5 (Item 5 from file: 2)

DIALOG(R)File 2:INSPEC

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6232173 INSPEC Abstract Number: A1999-11-4280S-009, B1999-06-6260M-011

Title: A WDM-PON using Fabry-Perot lasers as upstream **transmitters**

Author(s): Woodward, S.L.; Iannone, P.P.; Reichmann, K.C.; Frigo, N.J.

Author Affiliation: Newman Springs Lab., AT&T Lab. Res., Red Bank, NJ, USA

Conference Title: 1998 IEEE/LEOS Summer Topical Meeting. Digest. Broadband Optical Networks and Technologies: An Emerging Reality. Optical MEMS. Smart Pixels. Organic Optics and Optoelectronics (Cat. No.98TH8369) p.I/3-4

Publisher: IEEE, New York, NY, USA

Publication Date: 1998 Country of Publication: USA 254 pp.

ISBN: 0 7803 4953 9 Material Identity Number: XX-1998-02172

U.S. Copyright Clearance Center Code: 0 7803 4953 9/98/$10.00

Conference Title: 1998 IEEE/LEOS Summer Topical Meeting. Broadband Optical Networks and Technologies: An Emerging Reality. Optical MEMS. Smart Pixels. Organics Optics and Optoelectronics

Conference Sponsor: Opt. Soc. America

Conference Date: 20-24 July 1998 Conference Location: Monterey, CA, USA

Language: English

Subfile: A B

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Title: A WDM-PON using Fabry-Perot lasers as upstream **transmitters**

...Abstract: it has been proposed that broadband optical sources be used in the optical network unit (**ONU**). We demonstrate that Fabry-Perot lasers can be used as sources in a spectrally-sliced...

Identifiers: **upstream** transmitters...

22/3,K/6 (Item 6 from file: 2)

DIALOG(R)File 2:INSPEC

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6149158 INSPEC Abstract Number: B1999-03-6260F-023

Title: Design and implementation of a double-queue contention resolution algorithm for the ATM-PON system

Author(s): Jong-Wook Jang; Se-Ra Choi; Park, E.K.

Author Affiliation: Dept. of Comput. Eng., DongEui Univ., South Korea

Journal: Proceedings of the SPIE - The International Society for Optical Engineering Conference Title: Proc. SPIE - Int. Soc. Opt. Eng. (USA) vol.3531 p.121-9

Publisher: SPIE-Int. Soc. Opt. Eng,

Publication Date: 1998 Country of Publication: USA

CODEN: PSISDG ISSN: 0277-786X

SICI: 0277-786X(1998)3531L.121:DIDQ;1-R

Material Identity Number: C574-1998-294

U.S. Copyright Clearance Center Code: 0277-786X/98/$10.00

Conference Title: All-Optical Networking: Architecture, Control, and

Management Issues
Conference Sponsor: SPIE; IEEE Commun. Soc
Conference Date: 3-5 Nov. 1998 Conference Location: Boston, MA, USA
Language: English
Subfile: B
Copyright 1999, IEE
...Abstract: increases the world-wide market for the product. The MAC (medium access control) protocol controls **ONU** (optical network unit) access to the shared capacity on the PON, this product is very important if TDMA (time division multiple access) multiplexing is used on the **upstream** . In fact there are relatively large numbers of MAC proposals mentioning IEEE 802.14. The...
...Identifiers: **ONU** access

22/3,K/7 (Item 7 from file: 2)
DIALOG(R)File 2:INSPEC
(c) 2002 Institution of Electrical Engineers. All rts. reserv.

6131511 INSPEC Abstract Number: B1999-02-6220B-012
Title: VDSL transmission technology using 16-CAP/QPSK modulation scheme
Author(s): Rokugo, Y.; Kinosita, T.; Ohyama, Y.
Journal: NEC Technical Journal vol.51, no.8 p.41-5
Publisher: NEC,
Publication Date: Aug. 1998 Country of Publication: Japan
CODEN: NECGEZ ISSN: 0285-4139
SICI: 0285-4139(199808)51:8L.41:VTTU;1-2
Material Identity Number: H719-1998-011
Language: Japanese
Subfile: B
Copyright 1999, IEE

...Abstract: In FTTC, unshielded twisted-pair (UTP) cable is used as a distribution cable between the **ONU** and the home. This paper describes the very-high-speed digital subscriber line (VDSL) using 51 Mbit/s 16-carrierless-amplitude-phase-modulation (CAP) for the **downstream** and 1.6 Mbit/s quadrature phase shift keying (QPSK) for the **upstream** . Then this paper evaluates the transmission characteristics of VDSL using the UTP3 distribution cable.

22/3,K/8 (Item 8 from file: 2)
DIALOG(R)File 2:INSPEC
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6016128 INSPEC Abstract Number: B9810-6260-178
Title: Evolution-friendly upgrade of CATV networks towards a broadband full services access network
Author(s): van der Plaats, J.C.; Willems, F.W.; Koonen, A.M.J.
Author Affiliation: Bell Labs., Lucent Technol., Huizen, Netherlands
Conference Title: OFC '98. Optical Fiber Communication Conference and Exhibit. Technical Digest. Conference Edition. 1998 OSA Technical Digest Series Vol.2 (IEEE Cat. No.98CH36177) p.229-31
Publisher: Opt. Soc. America, Washington, DC, USA
Publication Date: 1998 Country of Publication: USA vii+421 pp.
ISBN: 1 55752 521 8 Material Identity Number: XX98-00580
U.S. Copyright Clearance Center Code: 1 55752 521 8/98/$6.00
Conference Title: OFC '98 Optical Fiber Communication Conference and Exhibit. Technical Digest Conference Edition 1998 OSA Technical Digest Series. Vol.2
Conference Sponsor: IEEE/Lasers & Electro-Opt. Soc.; IEEE Commun. Soc.; Opt. Soc. America
Conference Date: 22-27 Feb. 1998 Conference Location: San Jose, CA, USA
Language: English
Subfile: B
Copyright 1998, IEE

...Abstract: over an amplified 1:64 split ODN, with approximately 40 customer premises connected to one **ONU** , enables a maximum available capacity per IUP of400 kbit/s **downstream** and 100 kbit/s **upstream** and peak rates of 32 Mbit/s **downstream** and 8 Mbit/s **upstream** . The total number of customers that can be connected to this system is approximately 2400...

...Identifiers: **ONU** ;

22/3,K/9 (Item 9 from file: 2)

DIALOG(R)File 2:INSPEC

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5938894 INSPEC Abstract Number: B9807-6220B-029

Title: A Lab demonstration of a SuperPON optical access network

Author(s): Vandewege, J.; Qiu, X.Z.; Stubbe, B.; Coene, C.; Vaes, P.; Li, W.; Codenie, J.; Martin, C.; Slabbinck, H.; Van de Voorde, I.; Solina, P.; Obino, P.

Author Affiliation: IMEC, Ghent Univ., Gent, Belgium

Conference Title: Broadband Communications. The Future of Telecommunications. IFIP TC6/WG6.2 Fourth International Conference on Broadband Communications (BC'98) p.69-80

Editor(s): Kuhn, P.J.; Ulrich, R.

Publisher: Chapman & Hall, London, UK

Publication Date: 1998 Country of Publication: UK xiv+605 pp.

ISBN: 0 412 84410 9 Material Identity Number: XX97-03067

Conference Title: Proceedings of 4th International Conference on Broadband Communications '96

Conference Date: 1-3 April 1998 Conference Location: Stuttgart, Germany

Language: English

Subfile: B

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...Abstract: based ATM access network which can support a large number of subscriber optical network units (**ONU**), up to 2048, and cover a distance of 100 km. This contribution shows detailed results of **upstream** experiments carried out on newly developed fast switching and gain-controlled optical repeater units (ORU...

...to the introduction of cascaded SOA. Experimental results confirm that a SuperPON can service 2048 **ONU** over a distance of 100 km.

22/3,K/10 (Item 10 from file: 2)

DIALOG(R)File 2:INSPEC

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5926580 INSPEC Abstract Number: B9807-6260-018

Title: Network topologies for SuperPON

Author(s): Van de Voorde, I.; Oskar van Deventer, M.; Peters, P.J.M.; Crahay, P.; Jaunart, E.; Phillips, A.J.; Senior, J.M.; Qiu, X.Z.; Vandewege, J.; Binsma, J.J.M.; Vetter, P.J.

Author Affiliation: Res. Div., Alcatel Telecom, Antwerpen, Belgium

Conference Title: Conference on Optical Fiber Communications. Technical Digest. Postconference Edition. 1997 OSA Technical Digest Series. Vol.6 (IEEE Cat. No.97CH36049) p.57-8

Publisher: Opt. Soc. America, Washington, DC, USA

Publication Date: 1997 Country of Publication: USA ix+488 pp.

ISBN: 1 55752 480 7 Material Identity Number: XX97-00616

Conference Title: Proceedings of Optical Fiber Communication Conference (ISBN 1 55752 481 5)

Conference Sponsor: IEEE; Opt. Soc. America

Conference Date: 16-21 Feb. 1997 Conference Location: Dallas, TX, USA

Language: English

Subfile: B

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...Abstract: A bit rate of 2.5 Gbit/s is distributed to the optical

network units (**ONU**) by time-division multiplexing (TDM) in the **downstream** direction, whereas a time-division multiple access (TDMA) protocol is used to share the 311-Mbit/s **upstream** bit rate. Optical repeater units (ORUs) are integrated in the network to compensate for the ...
...Identifiers: **downstream** direction...

...Mbit/s **upstream** bit rate

22/3,K/11 (Item 11 from file: 2)
DIALOG(R)File 2:INSPEC
(c) 2002 Institution of Electrical Engineers. All rts. reserv.

5793861 INSPEC Abstract Number: B9802-6220B-005
Title: A gigabit-to-the-home (GTTH) system for future broadband access infrastructure
Author(s): Shibutani, M.; Ishikawa, H.; Tezuka, H.; Domon, W.; Soda, M.; Emura, K.
Author Affiliation: Opto-Electron. Res. Labs., NEC Corp., Kawasaki, Japan
Conference Title: 1997 IEEE International Conference on Communications. Towards the Knowledge Millennium. ICC '97. Conference Record (Cat. No.97CH36067) Part vol.2 p.1004-8 vol.2
Publisher: IEEE, New York, NY, USA
Publication Date: 1997 Country of Publication: USA 3 vol. xxviii+1743 pp.
ISBN: 0 7803 3925 8 Material Identity Number: XX97-01646
U.S. Copyright Clearance Center Code: 0 7803 3925 8/97/$10.00
Conference Title: Proceedings of ICC'97 - International Conference on Communications
Conference Date: 8-12 June 1997 Conference Location: Montreal, Que., Canada
Language: English
Subfile: B
Copyright 1998, IEE
...Abstract: its feasibility is investigated. GTTH is based on PON architecture and offers a very large **downstream** capacity of 2.5 Gb/s. Thus, various broadband communication services and digital video broadcasting...

... their signal formats, protocols and transfer modes. In order to reduce the cost of GTTH- **ONU** , a high-speed CMOS DMUX IC, a waveguide PIN-PD and a one-chip receiver...
...Identifiers: very large **downstream** capacity...

...GTTH- **ONU** ;

22/3,K/12 (Item 12 from file: 2)
DIALOG(R)File 2:INSPEC
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5621701 INSPEC Abstract Number: B9708-6260-082
Title: ATM super PON dimensioning for future residential and business demand
Author(s): Jaunart, E.; Crahay, P.
Conference Title: Broadband Superhighway, NOC '96. Proceedings of the European Conference on Networks and Optical Communications 1996 (NOC '96) p.89-96
Editor(s): Faulkner, D.W.; Harmer, A.L.
Publisher: IOS Press, Amsterdam, Netherlands
Publication Date: 1996 Country of Publication: Netherlands ix+346 pp.
Material Identity Number: XX96-00693
Conference Title: Proceedings of European Conference on Networks and Optical Communications
Conference Date: 24-28 June 1996 Conference Location: Heidelberg, Germany
Language: English

Subfile: B
Copyright 1997, IEE

...Abstract: address up to 2048 ONUs, the whole set of ONUs delivering a total STM-16 **downstream** capacity while a 2 STM-1 capacity would be available for the **upstream** . A feeder section up to 90 km and a distribution part up to 10 km...
...Identifiers: **ONU** ; ...

...STM-16 **downstream** capacity

22/3,K/13 (Item 13 from file: 2)
DIALOG(R)File 2:INSPEC
(c) 2002 Institution of Electrical Engineers. All rts. reserv.

5463587 INSPEC Abstract Number: B9702-6260-102
Title: Demonstration of performance-tiered modulators in a WDM PON with a single shared source
Author(s): Frigo, N.J.; Iannone, P.P.; Reichmann, K.C.; Walker, J.A.; Goossen, K.W.; Arney, S.C.; Murphy, E.J.; Ota, Y.; Swartz, R.G.
Author Affiliation: Crawford Hill Lab., AT&T Bell Labs., Holmdel, NJ, USA
Conference Title: 21st European Conference on Optical Communication, ECOC'95, including Symposium on Photonic versus Electronic Technologies in Switching and Interconnection. Symposium on Broadband Networks for Video and Multimedia Services (IEEE Cat. No.95TH8127) Part vol.1 p.441-4 vol.1
Publisher: IMEC, Gent, Belgium
Publication Date: 1995 Country of Publication: Belgium 4 vol. (xviii+iv+1102+147) pp.
Material Identity Number: XX95-01570
Conference Title: Proceedings of 21st European Conference on Optical Communications
Conference Date: 17-21 Sept. 1995 Conference Location: Brussels, Belgium
Language: English
Subfile: B
Copyright 1997, IEE

...Abstract: single optical source is shared by all subscribers. An optical modulator at each terminal impresses **upstream** data on portions of the **downstream** signals. Modulator choice is flexible and depends on customer willingness to pay for performance. We demonstrate this flexibility in a testbed with two optical network units (ONUs). One **ONU** includes a low-cost, low-performance micro-machined mechanical modulator while the other includes a...
...Identifiers: **upstream** data...

... **downstream** signals...

... **ONU** ;

22/3,K/14 (Item 14 from file: 2)
DIALOG(R)File 2:INSPEC
(c) 2002 Institution of Electrical Engineers. All rts. reserv.

5418652 INSPEC Abstract Number: B9612-6220B-028
Title: ATM SuperPON capacity dimensioning
Author(s): Jaunart, E.; Crahay, P.
Author Affiliation: Belgacom-Res. & New Dev., Brussels, Belgium
Conference Title: 1996 3rd International Workshop on Community Networking Proceedings. `Stories Behind the Picture' (Cat. No.96TH8187) p.61-4
Publisher: IEEE, New York, NY, USA
Publication Date: 1996 Country of Publication: USA vi+140 pp.
ISBN: 0 7803 3304 7 Material Identity Number: XX96-02359
U.S. Copyright Clearance Center Code: 0 7803 3304 7/96/$5.00
Conference Title: 3rd International Workshop on Community Networking

1996. Proceedings
Conference Sponsor: IEEE Commun. Soc.; Alcatel Telecom
Conference Date: 23-24 May 1996 Conference Location: Antwerpen, Belgium
Language: English
Subfile: B
Copyright 1996, IEE

...Abstract: address up to 2048 ONUs, the whole set of ONUs delivering a total STM-16 **downstream** capacity while a 2 STM-1 capacity would be available for the **upstream** . A feeder section up to 90 km and a distribution part up to 10 km...
...Identifiers: **ONU** ; ...

...STM-16 **downstream** capacity

22/3,K/15 (Item 15 from file: 2)
DIALOG(R)File 2:INSPEC
(c) 2002 Institution of Electrical Engineers. All rts. reserv.

5242205 INSPEC Abstract Number: B9605-6220B-025
Title: LARNet, a wavelength division multiplexed network for broadband local access
Author(s): Zirngibl, M.; Joyner, C.H.; Doerr, C.R.; Stulz, L.W.; Kaminow, I.P.
Author Affiliation: AT&T Bell Labs., Holmdel, NJ, USA
Conference Title: Broadband Communications. Networks, Services, Applications, Future Directions. 1996 International Zurich Seminar on Digital Communications, IZS `96. Proceedings p.311-19
Editor(s): Plattner, B.
Publisher: Springer-Verlag, Berlin, Germany
Publication Date: 1996 Country of Publication: West Germany xiv+358 pp.
ISBN: 3 540 60895 8 Material Identity Number: XX95-03164
Conference Title: Proceedings of International Seminar on Digital Communications
Conference Date: 21-23 Feb. 1996 Conference Location: Zurich, Switzerland
Language: English
Subfile: B
Copyright 1996, IEE
...Abstract: provides broadband switched services. A central office (GO) is connected to multiple optical network units (**ONU**) through a shared access fiber and a passive router in a remote node (RN). A...

...sends data simultaneously on all wavelengths; spectral slicing and a WDM receiver is employed for **upstream** connectivity. The WDM layout ensures independent virtual point-to-point links up-and **downstream** ; expensive components are shared among all ONUs; and the wavelength control problem becomes very simple. The **ONU** is built with inexpensive commercially available components. Aggregate rates of several Gbps **downstream** and several hundred Mbps **upstream** can be realized.
...Identifiers: **upstream** connectivity

22/3,K/16 (Item 1 from file: 8)
DIALOG(R)File 8:Ei Compendex(R)
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05485975 E.I. No: EIP00025056731
Title: Delivery of digital video and other multimedia services (greater than 1 Gb/s bandwidth) in passband above the 155 Mb/s baseband services on a FTTx full service access network
Author: Chand, Naresh; Magill, Peter D.; Swaminathan, Swami V.; Daugherty, Thomas H.
Corporate Source: Lucent Technologies, Murray Hill, NJ, USA
Source: Journal of Lightwave Technology v 17 n 12 1999. p 2449-2460

Publication Year: 1999
CODEN: JLTEDG ISSN: 0733-8724
Language: English

Abstract: For low cost passive optical access networks (PON), we have studied the **downstream** delivery of an additional greater than 1 Gb/s in the passband above the 155...

...switched multimedia services, i.e., digital video, data, and audio. For switched services, the baseband **upstream** will be the return path. Furthermore, the passband can be used to provide a dedicated...

...a 155 Mb/s baseband system, and is compatible with baseband only optical network unit (**ONU**). We multiplexed a 155.52 Mb/s baseband signal with quadrature phase shift keying (QPSK...

22/3,K/17 (Item 2 from file: 8)
DIALOG(R)File 8:Ei Compendex(R)
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05406151 E.I. No: EIP99104867177
Title: Delivery of gt; 1 Gb/s (digital video, data, and audio) downstream in passband above the 155-Mb/s baseband services on a FTTx full service access network
Author: Chand, Naresh; Magill, P.; Swaminathan, V.; Daugherty, T.H.
Corporate Source: Lucent Technologies, Murray Hill, NJ, USA
Source: IEEE Photonics Technology Letters v 11 n 9 1999. p 1192-1194
Publication Year: 1999
CODEN: IPTLEL ISSN: 1041-1135
Language: English

Title: Delivery of gt; 1 Gb/s (digital video, data, and audio) downstream in passband above the 155-Mb/s baseband services on a FTTx full service access...
Abstract: For low-cost passive optical access networks (PON), we have studied the **downstream** delivery of an additional gt; 1 Gb/s in the passband above the 155-Mb...

...a 155-Mb/s baseband system, and is compatible with baseband only optical network unit (**ONU**). We multiplexed a 155.52-Mb/s baseband signal with QPSK modulated passband gt; 1...
Identifiers: Passive optical access networks (PON); Optical network units (**ONU**); Optical to electrical (O/E) receivers

22/3,K/18 (Item 3 from file: 8)
DIALOG(R)File 8:Ei Compendex(R)
(c) 2002 Engineering Info. Inc. All rts. reserv.

04833397 E.I. No: EIP97103847043
Title: ONU RX using low-cost WDM splitter for 50 Mb/s PON
Author: Ota, Y.; Schafer, J.S.
Corporate Source: Lucent Technologies/Bell Lab, Holmdel, NJ, USA
Conference Title: Proceedings of the 1997 Pacific Rim Conference on Lasers and Electro-Optics, CLEO/Pacific Rim
Conference Location: Chiba, Jpn Conference Date: 19970714-19970718
E.I. Conference No.: 46984
Source: Pacific Rim Conference on Lasers and Electro-Optics, CLEO - Technical Digest 1997. IEEE, Piscataway, NJ, USA. p 71-72
Publication Year: 1997
CODEN: 002223
Language: English

Title: ONU RX using low-cost WDM splitter for 50 Mb/s PON
Abstract: The low-cost tapered fused (TF) WDM splitter for the optical network unit (**ONU**) is evaluated in the **down - stream** path of a passive optical network (PON) where both 1.31 mu m digital and...

Identifiers: Optical network unit (**ONU**); Passive optical network (PNO)

22/3,K/19 (Item 1 from file: 144)
DIALOG(R)File 144:Pascal
(c) 2002 INIST/CNRS. All rts. reserv.

14544434 PASCAL No.: 00-0209487
Delivery of $GRT1 Gb/s (digital video, data, and audio) downstream **in passband above the 155-Mb/s baseband services on a FTTx full service access network**
CHAND N; MAGILL P; SWAMINATHAN V; DAUGHERTY T H
Lucent Technologies, Murray Hill NJ, United States
Journal: IEEE Photonics Technology Letters, 1999, 11 (9) 1192-1194
Language: English

Delivery of $GRT1 Gb/s (digital video, data, and audio) downstream **in passband above the 155-Mb/s baseband services on a FTTx full service access** ...
For low-cost passive optical access networks (PON), we have studied the **downstream** delivery of an additional $GRT1 Gb/s in the passband above the 155-Mb/s...

...a 155-Mb/s baseband system, and is compatible with baseband only optical network unit (**ONU**). We multiplexed a 155.52-Mb/s baseband signal with QPSK modulated passband $GRT1.2...

English Descriptors: Passive optical access networks (PON); Optical network units (**ONU**); Optical to electrical (O/E) receivers; Theory; Optical communication; Optical fibers; Voice/data communication systems...

22/3,K/20 (Item 2 from file: 144)
DIALOG(R)File 144:Pascal
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14447397 PASCAL No.: 00-0106125
Semiconductor optical amplifier cascade modeling for the PLANET SuperPON
All-optical networking 1999 : architecture, control, and management issues : Boston MA, 19-21 September 1999
SENIOR J M; MOSS S E; QIU X Z; VANDEWEGE J
SENIOR John M, ed; CHUNMING QIAO, ed; DIXIT Sudhir, ed
Faculty of Engineering and Information Sciences, University of Hertfordshire, College Lane, Hatfield, AL10 9AB, United Kingdom; Department of Electrical and Electronic Engineering Manchester Metropolitan University, Chester Street, Manchester, M1 5GD, United Kingdom; IMEC, University of Gent, Sint-Pietersnieuwstraat 41, 9000 Gent, Belgium
International Society for Optical Engineering, Bellingham WA, United States.; IEEE. Communications Society, United States.
All-optical networking. Conference (Boston MA USA) 1999-09-19
Journal: SPIE proceedings series, 1999, 3843 190-196
Language: English

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... large range high-splitting ratio high-speed passive optical networks (SuperPONs). Optical amplification of both **upstream** and **downstream** traffic is necessary to sustain these configurations with several amplifiers in series throughout the network...

...an EU-ACTS project, was developed to operate at 2-5 Gbit/s in the **downstream** direction (from the head-end to the user optical network unit or **ONU**) and at 311 Mbit/s in the **upstream** . A laboratory-based system demonstrated the feasibility of the SuperPON concept over a span of 100 km to support a potential 2,048 optical network units. The **downstream** utilised erbium-doped fibre amplifiers (EDFAs) whereas in the **upstream** the use of burst-mode semiconductor optical amplifiers (SOAs) minimised noise funneling effects. Simulation results are presented in this paper for

the **upstream** SOA cascade. Data are provided for the evolution of both the signal power and the...

... of the noise figure with input power. Dispersion at 1300 nm, the possibility of another **ONU** ranging during the **upstream** transmission together with non-linear effects in fibre and optical amplifier were ignored. Complete polarisation...

... the transmitted ASE spectra for both "ones" and "zeros". The model was run against an **upstream** architecture for 1, 2 and 3 CW-operated SOAs in cascade. These architectures had been...

26/3,K/1 (Item 1 from file: 34)
DIALOG(R)File 34:SciSearch(R) Cited Ref Sci
(c) 2002 Inst for Sci Info. All rts. reserv.

04194058 Genuine Article#: RM322 No. References: 9
Title: TIME-DIVISION MULTIPLE-ACCESS PROTOCOL FOR A FIBEROPTIC PASSIVE DOUBLE STAR TRANSPORT-SYSTEM
Author(s): MIKI N; KUMOZAKI K
Corporate Source: NIPPON TELEGRAPH & TEL PUBL CORP,DEPT NETWORK SYST DEV,ACCESS NETWORK SYST PROJECT GRP/CHIBA 261//JAPAN/; NIPPON TELEGRAPH & TEL PUBL CORP,OPT NETWORK SYST LABS/YOKOSUKA/KANAGAWA 23803/JAPAN/
Journal: IEICE TRANSACTIONS ON COMMUNICATIONS, 1995, VE78B, N7 (JUL), P 995-1001
ISSN: 0916-8516
Language: ENGLISH Document Type: ARTICLE (Abstract Available)

...Abstract: system is considered. Dynamic time slot multiplexing based on TDMA is proposed to provide required **time slots** efficiently according to service changes. The effectiveness of dynamic time slot multiplexing is calculated and...

...TCM/TDMA frame structure and an access protocol enabling dynamic time slot multiplexing are proposed. **ONU** bandwidth is dynamically assigned by using a set of pointers. The **ONU** access protocol causes no interruption to operating ONUs on the same PDS system during the configuration or reconfiguration of an **ONU** . The access time is analyzed to estimate the performance of the access protocol. The probability...

28/3,K/1 (Item 1 from file: 2)
DIALOG(R)File 2:INSPEC
(c) 2002 Institution of Electrical Engineers. All rts. reserv.

7039459 INSPEC Abstract Number: B2001-10-6260F-052, C2001-10-5620L-051
Title: Ethernet **PON (ePON): Design and analysis of an** optical **access** network
Author(s): Kramer, G.; Mukherjee, B.; Pesavento, G.
Author Affiliation: Dept. of Comput. Sci., California Univ., Davis, CA, USA
Journal: Photonic Network Communications vol.3, no.3 p.307-19
Publisher: Kluwer Academic Publishers,
Publication Date: July 2001 Country of Publication: USA
CODEN: PNCOF9 ISSN: 1387-974X
SICI: 1387-974X(200107)3:3L.307:EEDA;1-#
Material Identity Number: H361-2001-003
U.S. Copyright Clearance Center Code: 1387-974X/2001/$19.50
Language: English
Subfile: B C
Copyright 2001, IEE

Title: Ethernet **PON (ePON): Design and analysis of an** optical **access** network
...Abstract: of services offered over the Internet, the "last mile" bottleneck problems continue to exacerbate. A **passive optical network** (PON) is a technology viewed by many as an attractive solution to this problem. In...

... ratio. This architecture uses the time-division multiplexing (TDM) approach to deliver data encapsulated in **Ethernet** packets from a collection of **optical network** units (ONUs) to a central **optical** line terminal (OLT) over the PON access **network** . The OLT, in turn, is connected to the rest of the Internet. A simulation model...

... queue occupancy. Then, we discuss the possibility of improving the bandwidth utilization by means of **time - slot** size adjustment, and by packet scheduling.
...Descriptors: **optical** fibre LAN...

... **optical** fibre subscriber loops...

...telecommunication **network** planning
Identifiers: **Ethernet** PON...

... **optical** access **network** ; ...

... **passive optical network** ; ...
... **Ethernet** packets...

... **optical network** units...

... **optical** line terminal...

... **time - slot** size adjustment

38/3,K/1 (Item 1 from file: 2)
DIALOG(R)File 2:INSPEC
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6390281 INSPEC Abstract Number: B1999-12-7130-006
Title: Intercomparison on PD calibrators and PD instruments
Author(s): Schon, K.; Lemke, E.; Bergman, A.; Garnacho, F.; Muhr, M.; Rizzi, G.; Sardi, A.; Lucas, W.; Elze, H.; Gunnarsson, O.; Simon, P.; Pack, S.; Giorgi, P.A.; **Pesavento, G.** ; Gobbo, R.; Gomez, F.N.; Domingues, F.; Blanc, I.; Hallstrom, J.; Zaengl, W.; Claudi, A.; Piiroinen, J.; Weber, H.J.; Brooks, R.
Author Affiliation: Phys.-Technische Bundesanstalt, Braunschweig, Germany
Conference Title: Eleventh International Symposium on High Voltage Engineering (Conf. Publ. No.467) Part vol.1 p.5-8 vol.1
Publisher: IEE, London, UK
Publication Date: 1999 Country of Publication: UK 5 vol. (xx+368+437+375+384+448) pp.
ISBN: 0 85296 719 5 Material Identity Number: XX-1999-00854
Conference Title: Proceedings of 11th International Symposium on High-Voltage Engineering (ISH 99)
Conference Sponsor: IEE
Conference Date: 23-27 Aug. 1999 Conference Location: London, UK
Language: English
Subfile: B
Copyright 1999, IEE
...Author(s): Sardi, A.; Lucas, W.; Elze, H.; Gunnarsson, O.; Simon, P.; Pack, S.; Giorgi, P.A.; **Pesavento, G.** ; Gobbo, R.; Gomez, F.N.; Domingues, F.; Blanc, I.; Hallstrom, J.; Zaengl, W.; Claudi...
Abstract: Within the **framework** of a European project, two partial discharge calibrators were circulated to thirteen laboratories for an...

38/3,K/2 (Item 2 from file: 2)
DIALOG(R)File 2:INSPEC
(c) 2002 Institution of Electrical Engineers. All rts. reserv.

6319433 INSPEC Abstract Number: B1999-09-6135-206, C1999-09-5260D-088
Title: Real-time content-based processing of multicast video
Author(s): Wensheng Zhou; Vellaikal, A.; Ye Shen; **Kuo, J.C.-C.**
Author Affiliation: Inf. Sci. Lab., HRL Labs., Malibu, CA, USA
Conference Title: Conference Record of Thirty-Second Asilomar Conference on Signals, Systems and Computers (Cat. No.98CH36284) Part vol.1 p. 882-6 vol.1
Editor(s): Matthews, M.B.
Publisher: IEEE, Piscataway, NJ, USA
Publication Date: 1998 Country of Publication: USA 2 vol. xxv+1891 pp.
ISBN: 0 7803 5148 7 Material Identity Number: XX-1999-00434
U.S. Copyright Clearance Center Code: 0 7803 5148 7/98/$10.00
Conference Title: Conference Record of Thirty-Second Asilomar Conference on Signals, Systems and Computers
Conference Date: 1-4 Nov. 1998 Conference Location: Pacific Grove, CA, USA
Language: English
Subfile: B C
Copyright 1999, IEE
Author(s): Wensheng Zhou; Vellaikal, A.; Ye Shen; **Kuo, J.C.-C.**
...Abstract: New on-line video feature extraction schemes, such as scene change detection, on-line key **frame** classification, are considered to meet the requirement of real-time video multicasting filtering based on...
...Identifiers: key **frame** classification...

38/3,K/3 (Item 3 from file: 2)
DIALOG(R)File 2:INSPEC
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6066231 INSPEC Abstract Number: A9823-9870J-016

Title: ORFEUS II far-ultraviolet observations of 3C 273: the intrinsic spectrum
Author(s): Appenzeller, I.; Krautter, J.; Mandel, H.; Bowyer, S.; Dixon, W.V.; Hurwitz, M.; Barnstedt, J.; Grewing, M.; Kappelmann, N.; **Kramer, G.**
Author Affiliation: Landessternwarte Konigstuhl, Heidelberg, Germany
Journal: Astrophysical Journal, Letters vol.500, no.1, pt.2 p.L9-12
Publisher: University of Chicago Press for American Astron. Soc,
Publication Date: 10 June 1998 Country of Publication: USA
CODEN: AJLEEY ISSN: 0004-637X
SICI: 0004-637X(19980610)500:1:2L.19:OUO2;1-O
Material Identity Number: M613-98019
Language: English
Subfile: A
Copyright 1998, IEE

...Author(s): Mandel, H.; Bowyer, S.; Dixon, W.V.; Hurwitz, M.; Barnstedt, J.; Grewing, M.; Kappelmann, N.; **Kramer, G.**
...Abstract: in the wavelength range 900-1200 AA (750-1040 AA in the QSO's rest **frame**). The QSO's spectrum is dominated by broad emission blends of the resonance lines of...

38/3,K/4 (Item 4 from file: 2)
DIALOG(R)File 2:INSPEC
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6051980 INSPEC Abstract Number: B9811-6140C-507, C9811-5260B-305
Title: An inexpensive video signal multiplexer for multicamera machine vision in automated analytical laboratory systems
Author(s): **Kramer, G.W.** ; Grandsard, P.J.
Author Affiliation: U.S. Dept. of Commerce, Nat. Inst. of Stand. & Technol., Gaithersburg, MD, USA
Journal: Laboratory Robotics and Automation vol.10, no.3 p.131-41
Publisher: Wiley,
Publication Date: 1998 Country of Publication: USA
CODEN: LRAUEY ISSN: 0895-7533
SICI: 0895-7533(1998)10:3L.131:IVSM;1-6
Material Identity Number: N847-98004
U.S. Copyright Clearance Center Code: 0895-7533/98/030131-11
Language: English
Subfile: B C
Copyright 1998, IEE

Author(s): **Kramer, G.W.** ; Grandsard, P.J.
...Abstract: described. The unit is used in conjunction with inexpensive charge-coupled-device video cameras, a **frame** grabber and computer interface, and commercially available image analysis software to detect events in an...

... The configuration presented here is an inexpensive alternative to systems that require more than one **frame** grabber in combination with multiple cameras or that use commercially available multiplexing **frame** grabbers.
...Identifiers: **frame** grabber

38/3,K/5 (Item 5 from file: 2)
DIALOG(R)File 2:INSPEC
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5729142 INSPEC Abstract Number: B9712-6210P-002, C9712-7410F-023
Title: On the prototyping, analysis and performance improvement of video conference systems on FDDI networks
Author(s): Chen, Y.C.; **Kuo, J.H.**
Author Affiliation: Dept. of Comput. Sci. & Inf. Eng., Nat. Chiao Tung Univ., Hsinchu, Taiwan
Journal: Journal of Information Science and Engineering vol.13, no.3 p.475-88

Publisher: Inst. Inf. Sci., Acad. Sinica,
Publication Date: Sept. 1997 Country of Publication: Taiwan
CODEN: JINEEY ISSN: 1016-2364
SICI: 1016-2364(199709)13:3L.475:PAPI;1-2
Material Identity Number: P823-97004
Language: English
Subfile: B C
Copyright 1997, IEE

Author(s): Chen, Y.C.; **Kuo, J.H.**
...Abstract: process, and derive a synchronous bandwidth reservation method to guarantee the delay-jitters of video **frame** transmissions. Our method is proven to fulfill the FDDI requirement.
...Identifiers: video **frame** transmissions

38/3,K/6 (Item 6 from file: 2)
DIALOG(R)File 2:INSPEC
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5629393 INSPEC Abstract Number: B9708-6250F-112
Title: FRAMES **-hybrid multiple access technology**
Author(s): Ojanpera, T.; Castro, J.; Emmer, D.; Gudmundson, M.; Jung, P.; Klein, A.; **Kramer, G.** ; Pirhonen, R.; Rademacher, L.; Skold, J.; Toskala, A.
Author Affiliation: NOKIA Res. Center, Helsinki, Finland
Conference Title: 1996 IEEE 4th International Symposium on Spread Spectrum Techniques and Applications Proceedings. Technical Program. (Cat. No.96TH8210) Part vol.1 p.320-4 vol.1
Publisher: IEEE, New York, NY, USA
Publication Date: 1996 Country of Publication: USA 3 vol. 1370 pp.
ISBN: 0 7803 3567 8 Material Identity Number: XX96-02206
U.S. Copyright Clearance Center Code: 0 7803 3567 8/96/$5.00
Conference Title: Proceedings of ISSSTA'95 International Symposium on Spread Spectrum Techniques and Applications
Conference Sponsor: IEEE; COMSOC; IEE; Univ. Kaiserslautern; U.R.S.I.; EiC; IEEE Commun. Soc. Chapter Germany
Conference Date: 22-25 Sept. 1996 Conference Location: Mainz, Germany
Language: English
Subfile: B
Copyright 1997, IEE
Title: FRAMES **-hybrid multiple access technology**
Author(s): Ojanpera, T.; Castro, J.; Emmer, D.; Gudmundson, M.; Jung, P.; Klein, A.; **Kramer, G.** ; Pirhonen, R.; Rademacher, L.; Skold, J.; Toskala, A.
...Abstract: the end of 1995 to support collaborative mobile research and development. Within ACTS the project **FRAMES** (Future Radio Wideband Multiple Access System) has been set up with an objective to define the UMTS radio access system. The first target of **FRAMES** is to investigate hybrid multiple access technologies and based on thorough evaluation of several candidate...
...Identifiers: **FRAMES** project

38/3,K/7 (Item 7 from file: 2)
DIALOG(R)File 2:INSPEC
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5590753 INSPEC Abstract Number: B9707-7310B-010
Title: The interaction between generating circuit and measuring system with respect to the implementation of IEC 60-2
Author(s): Gobbo, R.; **Pesavento, G.**
Author Affiliation: Padova Univ., Italy
Conference Title: High Voltage Measurement and Calibration. Conference Volume p.5.2/1-8
Publisher: ERA Technol, Leatherhead, UK
Publication Date: 1996 Country of Publication: UK vi+322 pp.
Material Identity Number: XX96-02262

Conference Title: Proceedings of 3rd European Conference on High Voltage Measurements and Calibration
Conference Date: 9-11 Oct. 1996 Conference Location: Milan, Italy
Language: English
Subfile: B
Copyright 1997, IEE

Author(s): Gobbo, R.; **Pesavento, G.**
...Abstract: or require modifications of all existing compact generators with the components grouped on the same **frame** . The paper intends to address these two points: the influence of the circuit arrangement and...

38/3,K/8 (Item 8 from file: 2)
DIALOG(R)File 2:INSPEC
(c) 2002 Institution of Electrical Engineers. All rts. reserv.

03668377 INSPEC Abstract Number: C90046820
Title: An integrated framework **for software prototyping**
Author(s): Jijun Chen; Junyen Wang; **Kuo, J.**
Author Affiliation: SEI, Wuhan Univ., Hubei, China
Conference Title: Proceedings of the 13th Annual International Computer Software and Applications Conference (Cat. No.89CH2743-3) p.463-70
Publisher: IEEE Comput. Soc. Press, Washington, DC, USA
Publication Date: 1989 Country of Publication: USA xx+793 pp.
ISBN: 0 8186 1964 3
U.S. Copyright Clearance Center Code: 0730-3157/89/0000-0463$01.00
Conference Sponsor: IEEE
Conference Date: 20-22 Sept. 1989 Conference Location: Orlando, FL, USA
Language: English
Subfile: C

Title: An integrated framework **for software prototyping**
Author(s): Jijun Chen; Junyen Wang; **Kuo, J.**
Abstract: An integrated **framework** for software prototyping is presented. The theme of the work is the integration of an...
... include both information management systems and reactive systems. A methodology for software prototyping in this **framework** and an effort to build an integrated prototyping environment are also discussed.
Identifiers: integrated **framework** ;

38/3,K/9 (Item 9 from file: 2)
DIALOG(R)File 2:INSPEC
(c) 2002 Institution of Electrical Engineers. All rts. reserv.

03442377 INSPEC Abstract Number: C89058679
Title: Computer automated design of structures under dynamic loads
Author(s): **Kramer, G.J.E.** ; Grierson, D.E.
Author Affiliation: Solid Mech. Div., Waterloo Univ., Ont., Canada
Journal: Computers and Structures vol.32, no.2 p.313-25
Publication Date: 1989 Country of Publication: UK
CODEN: CMSTCJ ISSN: 0045-7949
U.S. Copyright Clearance Center Code: 0045-7949/89/$3.00+0.00
Language: English
Subfile: C

Author(s): **Kramer, G.J.E.** ; Grierson, D.E.
Abstract: A computer-based structural design methodology is developed for the minimum weight design of planar **frameworks** subjected to dynamic loading. Constraints are placed on dynamic displacements, dynamic stresses, natural frequencies and...

... is capable of designing minimum weight structures under simultaneous static and dynamic loading. Several example **framework** designs are presented to illustrate the features of the design method.
...Identifiers: planar **frameworks** ;

38/3,K/10 (Item 10 from file: 2)
DIALOG(R)File 2:INSPEC
(c) 2002 Institution of Electrical Engineers. All rts. reserv.

03096347 INSPEC Abstract Number: C88019067
Title: Prototyping a software information base for software engineering environments
Author(s): **Kuo, J.H.** ; Tu, H.-C.
Author Affiliation: GTE Labs. Inc., Waltham, MA, USA
Conference Title: Proceedings of COMPSAC 87. The Eleventh Annual International Computer Software and Applications Conference (Cat. No.87CH2447-1) p.38-44
Publisher: IEEE Comput. Soc. Press, Washington, DC, USA
Publication Date: 1987 Country of Publication: USA xviii+750 pp.
ISBN: 0 8186 8806 8
U.S. Copyright Clearance Center Code: 0730-3157/87/0000-0038$01.00
Conference Sponsor: IEEE; Inf. Process. Soc. Japan
Conference Date: 7-9 Oct. 1987 Conference Location: Tokyo, Japan
Language: English
Subfile: C

Author(s): **Kuo, J.H.** ; Tu, H.-C.
...Abstract: base (SIB) for software engineering environments. The experiences in developing such a SIB as the **framework** of a software environment to facilitate tool integration, information expressiveness, and information processing are summarized...

38/3,K/11 (Item 11 from file: 2)
DIALOG(R)File 2:INSPEC
(c) 2002 Institution of Electrical Engineers. All rts. reserv.

02987162 INSPEC Abstract Number: A87121809
Title: Momentum distribution of protons in /sup 6/Li
Author(s): Lanen, J.B.J.M.; van den Berg, A.M.; van den Brand, J.F.J.; Hendriks, H.; den Herder, J.W.A.; Jans, E.; Kiezer, P.H.M.; **Kramer, G.J.** ; Lapikas, L.; Quint, E.N.M.; de Witt Huberts, P.K.A.; Blok, H.P.; Ent, R.; van der Steenhoven, G.
Author Affiliation: Fysisch Lab., Rijksuniv. Utrecht, Netherlands
Conference Title: Proceedings of the International Nuclear Physics Conference p.361 vol.1
Editor(s): Durrell, J.L.; Irvine, J.M.; Morrison, G.C.
Publisher: IOP, Bristol, UK
Publication Date: 1987 Country of Publication: UK 2 vol. (vii+556+xvi+606) pp.
Conference Sponsor: IUPAP
Conference Date: 25-30 Aug. 1986 Conference Location: Harrogate, Yorks., UK
Language: English
Subfile: A

...Author(s): F.J.; Hendriks, H.; den Herder, J.W.A.; Jans, E.; Kiezer, P.H.M.; **Kramer, G.J.** ; Lapikas, L.; Quint, E.N.M.; de Witt Huberts, P.K.A. ; Blok...
...Abstract: and calculations for the spectral function S(E/sub m/,p/sub m/) in the **framework** of alpha -d clustering for /sup 6/Li and alpha -n clustering for /sup 5...

38/3,K/12 (Item 1 from file: 6)
DIALOG(R)File 6:NTIS
(c) 2002 NTIS, Intl Cpyrght All Rights Res. All rts. reserv.

2134885 NTIS Accession Number: ADA365034/XAB
Extension of Relational Event Algebra to a General Decision Making Setting

(Professional paper)
Goodman, I. R. ; **Kramer, G. F.**
Space and Naval Warfare Systems Command, San Diego, CA.
Corp. Source Codes: 114813000; 434488
Jun 1998 11p
Languages: English Document Type: Journal article
Journal Announcement: GRAI9922
Pub. in Proceedings of International Multidisciplinary Conference, v1 p103-108, Oct 96.
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NTIS Prices: PC A03/MF A01

Goodman, I. R. ; **Kramer, G. F.**
... new motivation for the use of REA, as well as a more general decision-making **framework** where system performance and redundancy/ consistency tradeoffs are considered.

38/3,K/13 (Item 1 from file: 8)
DIALOG(R)File 8:Ei Compendex(R)
(c) 2002 Engineering Info. Inc. All rts. reserv.

05262180 E.I. No: EIP99034624712
Title: Real-time content-based processing of multicast video
Author: Zhou, Wensheng; Vellaikal, Asha; Shen, Ye; **Kuo, Jay C.-C.**
Corporate Source: LLC, Malibu, CA, USA
Conference Title: Proceedings of the 1998 32nd Asilomar Conference on Signals, Systems & Computers. Part 1 (of 2)
Conference Location: Pacific Grove, CA, USA Conference Date: 19981101-19981104
E.I. Conference No.: 50070
Source: Conference Record of the Asilomar Conference on Signals, Systems & Computers v 1 1998. IEEE Comp Soc, Los Alamitos, CA, USA,98CB36284. p 882-886
Publication Year: 1998
CODEN: CCSCE2 ISSN: 1058-6393
Language: English

Author: Zhou, Wensheng; Vellaikal, Asha; Shen, Ye; **Kuo, Jay C.-C.**
...Abstract: New on-line video feature extraction schemes, such as scene change detection, on-line key **frame** classification, are considered to meet the requirement of real-time video multicasting filtering based on...

38/3,K/14 (Item 2 from file: 8)
DIALOG(R)File 8:Ei Compendex(R)
(c) 2002 Engineering Info. Inc. All rts. reserv.

05107673 E.I. No: EIP98094363558
Title: New approach to requirements trade-off analysis for complex systems
Author: Lee, Jonathan; **Kuo, Jong-Yih**
Corporate Source: Natl Central Univ, Chungli, Taiwan
Source: IEEE Transactions on Knowledge and Data Engineering v 10 n 4 Jul-Aug 1998. p 551-562
Publication Year: 1998
CODEN: ITKEEH ISSN: 1041-4347
Language: English

Author: Lee, Jonathan; **Kuo, Jong-Yih**
...Abstract: the aggregation of individual requirements based on the requirements hierarchy. The proposed approach provides a **framework** for formally analyzing and modeling conflicts between requirements, and for users to better understand relationships...

38/3,K/15 (Item 3 from file: 8)
DIALOG(R)File 8:Ei Compendex(R)
(c) 2002 Engineering Info. Inc. All rts. reserv.

05086120 E.I. No: EIP98084329739
Title: Stagnant zones in granular moving bed filters for flue gas cleanup
Author: **Kuo, J.T.** ; Smid, J.; Hsiau, S.S.; Wang, C.Y.; Chou, C.S.
Corporate Source: Natl Taiwan Univ, Taipei, Taiwan
Source: Journal of Petroleum Science & Engineering v 20 n 1-2 Apr 1998. p 529-534
Publication Year: 1998
CODEN: JPSEE6 ISSN: 0920-4105
Language: English

Author: **Kuo, J.T.** ; Smid, J.; Hsiau, S.S.; Wang, C.Y.; Chou, C.S.
...Abstract: were recorded by videocamera throughout the whole test period. The image processing system including a **frame** grabber was used. Selected discrete images showing the flow pattern development were digitized and stored in files. Individual granular flow **frames** show a development of quasi-stagnant zones close to the louvered walls, the shear zones...

38/3,K/16 (Item 4 from file: 8)
DIALOG(R)File 8:Ei Compendex(R)
(c) 2002 Engineering Info. Inc. All rts. reserv.

04020568 E.I. No: EIP94122487427
Title: Planning from first principles for geometric constraint satisfaction
Author: Bhansali, Sanjay; **Kramer, Glenn A.**
Corporate Source: Washington State Univ, Pullman, WA, USA
Conference Title: Proceedings of the 12th National Conference on Artificial Intelligence. Part 1 (of 2)
Conference Location: Seattle, WA, USA Conference Date: 19940731-19940804
E.I. Conference No.: 21453
Source: Proceedings of the National Conference on Artificial Intelligence v 1 1994. AAAI, Menlo Park, CA, USA. p 319-324
Publication Year: 1994
CODEN: PNAIEE
Language: English

Author: Bhansali, Sanjay; **Kramer, Glenn A.**
Identifiers: Geometric constraint satisfaction; Geometric reasoning; Geometric bodies; Problem solving; **Frame** problem

38/3,K/17 (Item 5 from file: 8)
DIALOG(R)File 8:Ei Compendex(R)
(c) 2002 Engineering Info. Inc. All rts. reserv.

02959234 E.I. Monthly No: EIM9009-038710
Title: Integrated framework **for software prototyping.**
Author: Chen, Jijun; Wang, Junyen; **Kuo, Jeremy**
Corporate Source: Wuhan Univ, SEI, Wuhan, China
Conference Title: Proceedings of the Thirteenth Annual International Computer Software & Applications Conference - COMPSAC 89
Conference Location: Orlando, FL, USA Conference Date: 19890920
E.I. Conference No.: 13344
Source: Proceedings - IEEE Computer Society's International Computer Software & Applications Conference. Publ by IEEE, IEEE Service Center, Piscataway, NJ, USA. Available from IEEE Service Cent (cat n 89CH2743-3), Piscataway, NJ, USA. p 463-470
Publication Year: 1989
CODEN: PSICD2 ISSN: 0730-6512
Language: English

Title: Integrated framework **for software prototyping.**
Author: Chen, Jijun; Wang, Junyen; **Kuo, Jeremy**
Abstract: An integrated **framework** for software prototyping is presented. The theme of the work is the integration of an...
...include both information management systems and reactive systems. A methodology for software prototyping in this **framework** and an effort to build an integrated prototyping environment are also discussed. 20 Refs.

38/3,K/18 (Item 6 from file: 8)
DIALOG(R)File 8:Ei Compendex(R)
(c) 2002 Engineering Info. Inc. All rts. reserv.

02352763 E.I. Monthly No: EIM8711-078819
Title: OPTIMAL DESIGN OF STRUCTURES UNDER DYNAMIC LOADS.
Author: **Kramer, Gary J. E.** ; Grierson, Donald E.
Corporate Source: Univ of Waterloo, Ont, Can
Conference Title: Computer Applications in Structural Engineering, Proceedings of the Sessions at Structures Congress '87.
Conference Location: Orlando, FL, USA Conference Date: 19870817
E.I. Conference No.: 10257
Source: Publ by ASCE, New York, NY, USA p 326-341
Publication Year: 1987
Language: English

Author: **Kramer, Gary J. E.** ; Grierson, Donald E.
Abstract: A computer-based structural design methodology is developed for the minimum weight design of planar **frameworks** subjected to dynamic loading. Constraints are placed on dynamic displacements, dynamic stresses, natural frequencies and...

...is capable of designing minimum weight structures under simultaneous static and dynamic loading. Two example **frameworks** designs are presented to illustrate the features of the design method. (Author abstract) 9 refs.
...Descriptors: Light Weight; STRUCTURAL **FRAMES** --
Identifiers: OPTIMAL DESIGN; MINIMUM WEIGHT DESIGN; PLANAR **FRAMEWORKS**

38/3,K/19 (Item 1 from file: 34)
DIALOG(R)File 34:SciSearch(R) Cited Ref Sci
(c) 2002 Inst for Sci Info. All rts. reserv.

07139141 Genuine Article#: 128JD No. References: 17
Title: Identification of four novel mutations in the CYP21 gene in congenital adrenal hyperplasia in the Chinese
Author(s): Lee HH (REPRINT) ; Chao HT; Lee YJ; Shu SG; Chao MC; **Kuo JM** ; Chung BC
Corporate Source: VET GEN HOSP,DEPT OBSTET & GYNECOL/TAIPEI 11217//TAIWAN/ (REPRINT); MACKAY MEM HOSP,DEPT PEDIAT/TAIPEI//TAIWAN/; VET GEN HOSP,DEPT PEDIAT/TAICHUNG//TAIWAN/; KAOHSIUNG MED COLL,DEPT PEDIAT/KAOHSIUNG//TAIWAN/; ACAD SINICA,INST MOL BIOL/TAIPEI//TAIWAN/
Journal: HUMAN GENETICS, 1998, V103, N3 (SEP), P304-310
ISSN: 0340-6717 Publication date: 19980900
Publisher: SPRINGER VERLAG, 175 FIFTH AVE, NEW YORK, NY 10010
Language: English Document Type: ARTICLE (ABSTRACT AVAILABLE)

Author(s): Lee HH (REPRINT) ; Chao HT; Lee YJ; Shu SG; Chao MC; **Kuo JM** ; Chung BC
...Abstract: with no enzyme activity, respectively. Likewise, both the duplication and the deletion forms create a **frameshift** and premature stop during translation. The resulting proteins lack the heme-binding domain and hence...

38/3,K/20 (Item 2 from file: 34)
DIALOG(R)File 34:SciSearch(R) Cited Ref Sci
(c) 2002 Inst for Sci Info. All rts. reserv.

04302024 Genuine Article#: RU828 No. References: 23
Title: MAU(2)O(4) (M=SR, BA), THE FIRST OXOAURATES(III) WITH 3-DIMENSIONAL ANIONIC PARTIAL STRUCTURE
Author(s): **KRAMER G** ; JANSEN M
Corporate Source: UNIV BONN,INST ANORGAN CHEM,GERHARD DOMAGK STR 1/D-53121 BONN//GERMANY/; UNIV BONN,INST ANORGAN CHEM/D-53121 BONN//GERMANY/
Journal: JOURNAL OF SOLID STATE CHEMISTRY, 1995, V118, N2 (SEP), P247-253
ISSN: 0022-4596
Language: GERMAN Document Type: ARTICLE (Abstract Available)

Author(s): **KRAMER G** ; JANSEN M
...Abstract: stacked along [1 0 0] and [0 0 1] and connected to a three-dimensional **framework** by common corners. The alkaline earth ions are coordinated by eight oxygen atoms to form...

38/3,K/21 (Item 1 from file: 65)
DIALOG(R)File 65:Inside Conferences
(c) 2002 BLDSC all rts. reserv. All rts. reserv.

00495478 INSIDE CONFERENCE ITEM ID: CN004779824
A Framework **for Sonification Design**
Madhyastha, T. M.; Reed, D. A.
CONFERENCE: Auditory display sonification audification and auditory interfaces -Meeting
SANTA FE INSTITUTE STUDIES IN THE SCIENCE OF COMPLEXITY - PROCEEDINGS
VOLUME-, 1994; VOL 18 P: 267-290
Addison-Wesley, 1994
ISBN: 0201626039
LANGUAGE: English DOCUMENT TYPE: Conference Papers
CONFERENCE EDITOR(S): **Kramer, G.**
CONFERENCE LOCATION: Sante Fe, NM
CONFERENCE DATE: Oct 1992 (199210) (199210)

A Framework **for Sonification Design**
CONFERENCE EDITOR(S): **Kramer, G.**

38/3,K/22 (Item 1 from file: 77)
DIALOG(R)File 77:Conference Papers Index
(c) 2002 Cambridge Sci Abs. All rts. reserv.

Supplier Accession Number: 85062656 V13N11
Optimal synthesis of frameworks under dynamic loads
Grierson, D.E.; Kramer, G.J.E.
Univ. Waterloo
Tenth Canadian Congress of Applied Mechanics -- CANCAM '85 8520137
London (Canada) 2-7 Jun 1985
University of Western Ontario; Natural Sciences and Engineering Research Council
Secretary, CANCAM '85, Room 3030, EMSc Building, University of Western Ontario, London, Canada N6A 5B9, Price -- $45.00 Canadian payable to CANCAM '85

38/3,K/23 (Item 1 from file: 144)
DIALOG(R)File 144:Pascal
(c) 2002 INIST/CNRS. All rts. reserv.

10667446 PASCAL No.: 93-0176733
A comparison of two methods of test equating in the Rasch model
SMITH R M; **KRAMER G A**
Univ. South Florida, USA
Journal: Educational and psychological measurement, 1992, 52 (4) 835-846
Language: English

SMITH R M; **KRAMER G A**

... Test. Simulated data patterned after the observed item difficulties were also analyzed to form a **frame** of reference against which to judge the accuracy of the equating

File 233:Internet & Personal Comp. Abs. 1981-2002/Apr
(c) 2002 Info. Today Inc.
File 256:SoftBase:Reviews,Companies&Prods. 85-2002/Apr
(c)2002 Info.Sources Inc

Set	Items	Description
S1	0	ETHERNET()PASSIVE()OPTICAL?()NETWORK?
S2	1	EPON??
S3	8577	FRAME?
S4	3	ETHERNET AND PASSIVE AND OPTICAL? AND NETWORK?
S5	0	ONU AND FRAME? AND OPTICAL? AND NETWORK?
S6	227	DOWNSTREAM? OR UPSTREAM? OR (DOWN OR UP)()STREAM?
S7	0	ONU AND TIME()SLOTS
S8	0	(EPON OR EPONS OR ONU) AND TIME(5N)SLOTS
S9	5	AU=(KUO J? OR KUO, J? OR GRUIA D? OR GRUIA, D? OR KRAMER G? OR KRAMER, G? OR PESAVENTO G? OR PESAVENTO, G?)
S10	2	S4 NOT S2
S11	10	S3 AND S6

2/3,K/1 (Item 1 from file: 233)
DIALOG(R)File 233:Internet & Personal Comp. Abs.
(c) 2002 Info. Today Inc. All rts. reserv.

00651850 01NW12-014
Lesson 161: passive optical networks
Greenfield, David
Network Magazine Incorporating Data Communications , December 1, 2001 , v16 n12 p30-31, 2 Page(s)
ISSN: 1093-8001

... often talked about application for VDSL. Describes ATM-based PON (APON) and Ethernet-based PON (**EPON**). Includes a photo, a sidebar, and two diagrams. (MEM)

10/3,K/1 (Item 1 from file: 233)
DIALOG(R)File 233:Internet & Personal Comp. Abs.
(c) 2002 Info. Today Inc. All rts. reserv.

00630291 01NR05-312
Industry veterans launch newest optical **access firm**
Gimpelson, Terri
Network World , May 28, 2001 , v18 n22 p38, 1 Page(s)
ISSN: 0887-7661
Company Name: Salira **Optical Network** Systems
URL: http://www.salira.com

Industry veterans launch newest optical **access firm**
Company Name: Salira **Optical Network** Systems
Profiles emerging company Salira **Optical Network** Systems, based in San Jose, CA. Reports that Salira is managed by seasoned information technology (IT) vendors from companies such as Nortel **Networks** , Intel, Bay **Networks** , and Cylink. Cites the goal to provide **optical** access for broadband services with **Ethernet** working at the media access control (MAC) layer. Mentions the advantages of **Ethernet** over asynchronous transfer mode (ATM): cost; bandwidth; ability to scale from 1.25Gbps to 10Gbps...

... s products will be able to handle multilayer switching, Multiprotocol Label Switching (MPLS), virtual private **networks** (VPNs), video, voice, and data, all based on an **Ethernet** -enabled **passive optical network** (PON). Includes a sidebar. (MEM)
Descriptors: Corporate Information; Fiber-optics; **Ethernet** ; Broadband Communication; Asynchronous Transfer Mode; Internet Backbone; **Networks**
Identifiers: Salira **Optical Network** Systems

10/3,K/2 (Item 1 from file: 256)
DIALOG(R)File 256:SoftBase:Reviews,Companies&Prods.
(c)2002 Info.Sources Inc. All rts. reserv.

00131149 DOCUMENT TYPE: Review

PRODUCT NAMES: Company - Salira Optical Network **Systems Inc (874671**

TITLE: Industry veterans launch newest optical **access firm**
AUTHOR: Gimpelson, Terri
SOURCE: Network World, v18 n22 p38(1) May 28, 2001
ISSN: 0887-7661
HOMEPAGE: http://www.nwfusion.com

RECORD TYPE: Review
REVIEW TYPE: Company

REVISION DATE: 20010830

PRODUCT NAMES: Company - Salira Optical Network **Systems Inc...**

TITLE: Industry veterans launch newest optical **access firm**

Salira **Optical Network** Systems, the provider of an **EtherNet** over PON product, is a new company that aims to 'develop products that would let carriers provision **optical EtherNet** access to the Internet.' Salira was founded by industry heavyweights CEO Herb Martin, CTO Wei...

...13 patents pending and seven more under review. Martin says Salira wants to provide its **optical** access at the media access control (MAC) layer. He says **EtherNet** has many advantages over ATM, including cost advantages, intrinsic bandwidth advantages with **EtherNet** , and the ability to scale from 1.25Gbit/second up to 10Gbit/second and beyond. Martin also says **EtherNet** provides streamlined service provisioning, more dynamic bandwidth

allocation, and 'de facto parity with ATM on...

...Multi- protocol Label Switching, VPNs, video, voice and data, all of which will use an **EtherNet** -based **passive optical network** . Martin calls **EtherNet** over PON a 'technology enabler for carriers.' Alloptic is Salira's biggest competitor and also calls itself a pioneer in development of **EtherNet** PONs. An analyst says Salira could provide the industry with many positive innovations, including 'dynamic...

COMPANY NAME: Salira **Optical Network** Systems Inc...
DESCRIPTORS: **Optical Networks** ; LANs; **Network** Software; **EtherNet**

```
File 344:CHINESE PATENTS ABS APR 1985-2002/MAR
         (c) 2002 EUROPEAN PATENT OFFICE
File 347:JAPIO Oct/1976-2001/Dec(Updated 020401)
         (c) 2002 JPO & JAPIO
File 350:Derwent WPIX 1963-2001/UD,UM &UP=200226
         (c) 2002  Thomson Derwent

Set     Items   Description
S1          0   ETHERNET()PASSIVE()OPTICAL?()NETWORK?
S2        262   EPON??
S3     829333   FRAME?
S4          1   ETHERNET AND PASSIVE AND OPTICAL? AND NETWORK?
S5         22   ONU AND FRAME? AND OPTICAL? AND NETWORK?
S6     160189   DOWNSTREAM? OR UPSTREAM? OR (DOWN OR UP)()STREAM?
S7          4   ONU AND TIME()SLOTS
S8          4   (EPON OR EPONS OR ONU) AND TIME(5N)SLOTS
S9        332   AU=(KUO J? OR KUO, J? OR GRUIA D? OR GRUIA, D? OR KRAMER G?
                OR KRAMER, G? OR PESAVENTO G? OR PESAVENTO, G?)
S10         0   S2 AND S3 AND S6
S11         0   S8 NOT S7
S12         0   S9 AND S3 AND S6
S13         0   S2 AND S9
S14        29   S9 AND S3
S15         4   S14 AND ETHERNET
S16         4   S15 NOT (S4 OR S7)
```

4/3,K/1 (Item 1 from file: 350)
DIALOG(R)File 350:Derwent WPIX
(c) 2002 Thomson Derwent. All rts. reserv.

010889651 **Image available**
WPI Acc No: 1996-386602/199639
XRPX Acc No: N96-325833
Digital optical receiver for burst signal transmission in PON - converts optical to electric signal, amplifies to preset level to provide two signals, gives two logical decision signals with intermediate values between amplifier signals amplitude values and logic signal based on decision signals
Patent Assignee: NEC CORP (NIDE)
Inventor: SAITO T
Number of Countries: 006 Number of Patents: 003
Patent Family:

Patent No	Kind	Date	Applicat No	Kind	Date	Week	
EP 729243	A2	19960828	EP 96301276	A	19960226	199639	B
JP 8293838	A	19961105	JP 9634683	A	19960222	199703	
US 5822104	A	19981013	US 96606377	A	19960223	199848	

Priority Applications (No Type Date): JP 9536722 A 19950224
Patent Details:

Patent No	Kind	Lan	Pg	Main IPC	Filing Notes
EP 729243	A2	E	15	H04B-010/158	
Designated States (Regional): DE FR GB PT					
JP 8293838	A		11	H04B-010/28	
US 5822104	A			H04B-010/06	

Digital optical receiver for burst signal transmission in PON...

...**converts optical to electric signal, amplifies to preset level to provide two signals, gives two logical decision...**

...Abstract (Basic): The digital **optical** receiving circuit includes an opto-electric convertor for converting an **optical** signal into an electric signal. An amplifier (3) amplifies the signal to a predetermined level...

...USE/ADVANTAGE - For use with PON, **optical** transmission system or **optical Ethernet** communication system. Minimises degradation of signal amplitude...
...Title Terms: **OPTICAL** ;

7/3,K/1 (Item 1 from file: 350)
DIALOG(R)File 350:Derwent WPIX
(c) 2002 Thomson Derwent. All rts. reserv.

013887966 **Image available**
WPI Acc No: 2001-372179/200139
XRPX Acc No: N01-272260
Packet data communication system changes specified packet receiving time slots **corresponding to packet size, by using generated setting modification signals**
Patent Assignee: NEC CORP (NIDE)
Number of Countries: 001 Number of Patents: 001
Patent Family:

Patent No	Kind	Date	Applicat No	Kind	Date	Week	
JP 2001111588	A	20010420	JP 99283879	A	19991005	200139	B

Priority Applications (No Type Date): JP 99283879 A 19991005
Patent Details:

Patent No	Kind	Lan	Pg	Main IPC	Filing Notes
JP 2001111588	A		8	H04L-012/44	

Packet data communication system changes specified packet receiving time slots **corresponding to packet size, by using generated setting modification signals**
Abstract (Basic):
... OSU and **ONU** control sections (38,62M) set maximum packet size (50M, 80M) and transmits packets, based on...

...on preset reference signals. Based on signals (52,82M), control section (37) changes specified receiving **time slots** of packets related to packet size and receives preset modified time slot.
... **ONU** control section (62M

7/3,K/2 (Item 2 from file: 350)
DIALOG(R)File 350:Derwent WPIX
(c) 2002 Thomson Derwent. All rts. reserv.

012581207 **Image available**
WPI Acc No: 1999-387314/199933
XRPX Acc No: N99-290200
Protocol with reserved time frame slots for optical fiber communication network
Patent Assignee: ALCATEL (COGE)
Inventor: BELLER D; KOERPER R; MEYER H
Number of Countries: 025 Number of Patents: 002
Patent Family:

Patent No	Kind	Date	Applicat No	Kind	Date	Week	
EP 924885	A2	19990623	EP 98440274	A	19981127	199933	B
DE 19755908	A1	19990617	DE 1055908	A	19971216	199933	

Priority Applications (No Type Date): DE 1055908 A 19971216
Patent Details:

Patent No	Kind	Lan	Pg	Main IPC	Filing Notes
EP 924885	A2	G	7	H04B-010/213	
Designated States (Regional): AL AT BE CH CY DE DK ES FI FR GB GR IE IT LI LT LU LV MC MK NL PT RO SE SI					
DE 19755908	A1			H04L-029/06	

Abstract (Basic):
... The optical fiber network has a number of communication cables (**ONU** 1..) that are connected to a hub (HUB). Coupled onto the cables are subscriber modules (STB 1..) and each of these are assigned reserved specific **time slots** for communication. The time slot assignment is made to an established protocol.
... Optical fiber cables (**ONU** 1...

7/3,K/3 (Item 3 from file: 350)
DIALOG(R)File 350:Derwent WPIX
(c) 2002 Thomson Derwent. All rts. reserv.

012029548 **Image available**
WPI Acc No: 1998-446458/199838
XRPX Acc No: N98-348021
Optical communication system with path characteristics monitoring function - judges existence of second packet arranged in sequential nonoverlapping time slots **in optical signal received from** ONU , **when power margin of feeder fibre is above threshold value**
Patent Assignee: LUCENT TECHNOLOGIES INC (LUCE)
Inventor: FRIGO N J
Number of Countries: 001 Number of Patents: 001
Patent Family:

Patent No	Kind	Date	Applicat No	Kind	Date	Week	
US 5790293	A	19980804	US 95549588	A	19951027	199838	B

Priority Applications (No Type Date): US 95549588 A 19951027
Patent Details:

Patent No	Kind	Lan	Pg	Main IPC	Filing Notes
US 5790293	A		8	H04B-010/12	

... **judges existence of second packet arranged in sequential nonoverlapping** time slots **in optical signal received from** ONU , **when power margin of feeder fibre is above threshold value**

...Abstract (Basic): The system includes a central terminal (10) and several optical network units (**ONU**) (18,20,22) connected through unidirectional feeder fibres (14,18), respectively. A transmitter (12) provided in the central terminal outputs amplitude varying optical signals to the **ONU** . The signal is divided into two packets with amplitude exceeding threshold value and lying between...

...The first and second packets are set in sequential non overlapping **time slots** . A receiver (16) provided in the central terminal receives the signals transmitted from the ONUs...

7/3,K/4 (Item 4 from file: 350)
DIALOG(R)File 350:Derwent WPIX
(c) 2002 Thomson Derwent. All rts. reserv.

011585016 **Image available**
WPI Acc No: 1998-002145/199801
XRPX Acc No: N98-001689
Optical network unit for data packet reception among reference pulses - has reference pulses extractor, from received signal mixture, for synchronisation with data stream generated for transmission
Patent Assignee: ALCATEL (COGE); ALCATEL ALSTHOM CIE GEN ELECTRICITE (COGE); ALCATEL SEL AG (COGE)
Inventor: PFEIFFER T
Number of Countries: 015 Number of Patents: 007
Patent Family:

Patent No	Kind	Date	Applicat No	Kind	Date	Week	
EP 809372	A2	19971126	EP 97401047	A	19970509	199801	B
DE 19620723	A1	19971127	DE 1020723	A	19960523	199802	
AU 9723497	A	19971127	AU 9723497	A	19970519	199805	
CA 2205990	A	19971123	CA 2205990	A	19970516	199823	
JP 10084322	A	19980331	JP 97132615	A	19970522	199823	
US 6011637	A	20000104	US 97855377	A	19970513	200008	N
AU 715257	B	20000120	AU 9723497	A	19970519	200015	

Priority Applications (No Type Date): DE 1020723 A 19960523; US 97855377 A 19970513
Patent Details:

Patent No	Kind	Lan	Pg	Main IPC	Filing Notes
EP 809372	A2	G	9	H04J-013/00	

Designated States (Regional): AT BE CH DE ES FR GR IT LI NL SE

AU	715257	B		H04B-010/20 Previous Publ. patent AU 9723497
DE	19620723	A1	8	H04L-012/56
JP	10084322	A	7	H04B-010/20
US	6011637	A		H04J-013/00
AU	9723497	A		H04B-010/20
CA	2205990	A		H04B-010/14

...Abstract (Basic): mixtures of reference pulses from a central laser diode (LAS) and data packets transmitted in **time slots** between the reference pulses...

...Each **ONU** has a processor (UNIT1) checking for the presence of data packets within the mixtures of...

?

16/3,K/1 (Item 1 from file: 350)
DIALOG(R)File 350:Derwent WPIX
(c) 2002 Thomson Derwent. All rts. reserv.

013697126 **Image available**
WPI Acc No: 2001-181350/200118
XRPX Acc No: N01-129290
Data frame **associated status information storing method in packet switched network, involves determining presence of one complete stored** frame **in buffer memory, asynchronously**
Patent Assignee: ADVANCED MICRO DEVICES INC (ADMI)
Inventor: **KUO J C** ; LAI P; NIU A J
Number of Countries: 001 Number of Patents: 001
Patent Family:

Patent No	Kind	Date	Applicat No	Kind	Date	Week	
US 6154796	A	20001128	US 98146168	A	19980903	200118	B

Priority Applications (No Type Date): US 98146168 A 19980903
Patent Details:

Patent No	Kind	Lan	Pg	Main IPC	Filing Notes
US 6154796	A		13	G06F-013/14	

Data frame **associated status information storing method in packet switched network, involves determining presence of one complete stored** frame **in buffer memory, asynchronously**
Inventor: **KUO J C** ...

Abstract (Basic):
... The **frame** and corresponding status information are written in random access buffer memory. The written information is...

...and input to register, based on another independent clock. The presence of one complete stored **frame** in memory is determined asynchronously and the written stored information are stored, selectively.
... For buffering data between host bus interface and media access controller accessing **ethernet** media...

...status information in a holding register, the read controller may quickly examine whether the data **frame** should be read or discarded. Offers faster access speeds, smaller memory sizes and faster flushing ...
...Title Terms: **FRAME** ;

16/3,K/2 (Item 2 from file: 350)
DIALOG(R)File 350:Derwent WPIX
(c) 2002 Thomson Derwent. All rts. reserv.

013483349 **Image available**
WPI Acc No: 2000-655292/200063
XRPX Acc No: N00-485709
Bit comparison result output method involves supplying long bit value selectively to one of the memory controller which is configured for reading data frame **based on host bus clock**
Patent Assignee: ADVANCED MICRO DEVICES INC (ADMI)
Inventor: **KUO J C** ; LAI P; NIU A J
Number of Countries: 001 Number of Patents: 001
Patent Family:

Patent No	Kind	Date	Applicat No	Kind	Date	Week	
US 6105079	A	20000815	US 97993058	A	19971218	200063	B

Priority Applications (No Type Date): US 97993058 A 19971218
Patent Details:

Patent No	Kind	Lan	Pg	Main IPC	Filing Notes
US 6105079	A		14	G06F-013/14	

... **bit value selectively to one of the memory controller which is**

configured for reading data frame **based on host bus clock**
Inventor: **KUO J C** ...

Abstract (Basic):
... is supplied selectively to one of second memory controller which is configured for reading data **frame** from buffer memory onto host bus based on host bus clock. Memory location in buffer memory is reserved for storing status information related to data **frame** based on presence of at least one data **frame** in memory.
... Length of data **frame** received from network is determined and long bit comparison result is selectively generated based on comparison result of data **frame** length and preset threshold value. The first memory controller is configured to store data **frame** in buffer memory based on network clock. An INDEPENDENT CLAIM is also included for network...

...For buffering data between host bus interface and media access controller accessing **ethernet** media and for transmission of data packets between host computer and network communication system such...

...Even though less than one complete **frame** is stored in RAM, on receiving long bit comparison result, a host bus transfer interrupt is initiated for corresponding data **frame** .
...Title Terms: **FRAME** ;

16/3,K/3 (Item 3 from file: 350)
DIALOG(R)File 350:Derwent WPIX
(c) 2002 Thomson Derwent. All rts. reserv.

013446446 **Image available**
WPI Acc No: 2000-618389/200059
XRPX Acc No: N00-458228
Data frame **storage monitoring method in buffer memory, involves updating header information in portion of prescribed location in random access memory reserved**
Patent Assignee: ADVANCED MICRO DEVICES INC (ADMI)
Inventor: **KUO J C** ; LAI P; NIU A J
Number of Countries: 001 Number of Patents: 001
Patent Family:

Patent No	Kind	Date	Applicat No	Kind	Date	Week	
US 6128308	A	20001003	US 97993063	A	19971218	200059	B

Priority Applications (No Type Date): US 97993063 A 19971218
Patent Details:

Patent No	Kind	Lan	Pg	Main IPC	Filing Notes
US 6128308	A		11	H04L-012/54	

Data frame **storage monitoring method in buffer memory, involves updating header information in portion of prescribed location...**
Inventor: **KUO J C** ...

Abstract (Basic):
... of prescribed location in random access memory is reserved for header information corresponding to a **frame** received from a host computer bus. The **frame** is then written in another portion of the prescribed memory location. The memory location portion...
... so that a single bit of counter value changed, in response to the storage of **frame** in the prescribed location using write controller. The **frame** is then read using a read controller and the signal is supplied to another counter...

...counter is changed. The counter values are compared to determine presence of stored at a **frame** in random access memory and comparison result indicating the presence of less than one complete **frame** and the presence of one **frame** is generated...

...For buffering between host bus interface and media access controller

accessing **ethernet** media for network interfacing...
...Title Terms: **FRAME** ;

16/3,K/4 (Item 4 from file: 350)
DIALOG(R)File 350:Derwent WPIX
(c) 2002 Thomson Derwent. All rts. reserv.

013203548 **Image available**
WPI Acc No: 2000-375421/200032
XRPX Acc No: N00-281979
Data frame **processing for interface device used in packet switched network such as an** Ethernet **network, uses the presence of a data** frame **determined based on storing and reading procedures**
Patent Assignee: ADVANCED MICRO DEVICES INC (ADMI)
Inventor: **KUO J C** ; LAI P; NIU A J
Number of Countries: 001 Number of Patents: 001
Patent Family:

Patent No	Kind	Date	Applicat No	Kind	Date	Week	
US 6061768	A	20000509	US 97993891	A	19971218	200032	B

Priority Applications (No Type Date): US 97993891 A 19971218
Patent Details:

Patent No	Kind	Lan	Pg	Main IPC	Filing Notes
US 6061768	A		13	G06F-013/00	

Data frame **processing for interface device used in packet switched network such as an** Ethernet **network, uses the presence of a data** frame **determined based on storing and reading procedures**
Inventor: **KUO J C** ...

Abstract (Basic):
... The presence of at least one data **frame** stored in the RAM is asynchronously determined based on the storing and reading procedures utilized...

...the synchronization circuit. The initial tracking information and the tracking information of the read data **frame** are selectively stored into the holding register if a stored data **frame** exists and the stored tracking information indicating a read status.
... A write controller, operating according to a first clock, is used to store each data **frame** received by the network interface device and the corresponding tracking information into a random access ...

...holding register. A read controller, operating according to an independent clock, then reads the data **frame** from the RAM, after which the corresponding tracking information is supplied to the synchronization circuit...

...For interface device used packet switched network e.g. **Ethernet** network...
...operations to and from RAM to enable efficient memory management for monitoring status of stored **frame** data...
...Title Terms: **FRAME** ;
?

```
File   9:Business & Industry(R) Jul/1994-2002/Apr 25
         (c) 2002 Resp. DB Svcs.
File  15:ABI/Inform(R) 1971-2002/Apr 26
         (c) 2002 ProQuest Info&Learning
File 484:Periodical Abs Plustext 1986-2002/Apr W4
         (c) 2002 ProQuest
File 553:Wilson Bus. Abs. FullText 1982-2002/Apr
         (c) 2002 The HW Wilson Co
File 624:McGraw-Hill Publications 1985-2002/Apr 24
         (c) 2002 McGraw-Hill Co. Inc
File  88:Gale Group Business A.R.T.S. 1976-2002/Apr 24
         (c) 2002 The Gale Group
File 275:Gale Group Computer DB(TM) 1983-2002/Apr 25
         (c) 2002 The Gale Group
File 570:Gale Group MARS(R) 1984-2002/Apr 25
         (c) 2002 The Gale Group
File 621:Gale Group New Prod.Annou.(R) 1985-2002/Apr 25
         (c) 2002 The Gale Group
File 636:Gale Group Newsletter DB(TM) 1987-2002/Apr 25
         (c) 2002 The Gale Group
File 613:PR Newswire 1999-2002/Apr 26
         (c) 2002 PR Newswire Association Inc
File 623:Business Week 1985-2002/Apr 25
         (c) 2002 The McGraw-Hill Companies Inc
File 610:Business Wire 1999-2002/Apr 26
         (c) 2002 Business Wire.
File 141:Readers Guide 1983-2002/Mar
         (c) 2002 The HW Wilson Co

Set     Items   Description
S1         31   ETHERNET()PASSIVE()OPTICAL?()NETWORK?
S2        852   EPON??
S3     777787   FRAME?
S4        194   ETHERNET(S)PASSIVE(S)OPTICAL?(S)NETWORK?
S5          4   ONU(S)FRAME?(S)OPTICAL?(S)NETWORK?
S6          3   ONU(S)TIME()SLOTS
S7       2134   S3(S)(DOWNSTREAM? OR UPSTREAM? OR (DOWN OR UP)()STREAM?)
S8          3   (EPON OR EPONS OR ONU)(S)TIME(5N)SLOTS
S9        255   AU=(KUO J? OR KUO, J? OR GRUIA D? OR GRUIA, D? OR KRAMER G?
                OR KRAMER, G? OR PESAVENTO G? OR PESAVENTO, G?)
S10        23   (S1 OR S2 OR S4)(S)S3
S11        12   S10 NOT PY=>2000
S12        11   RD S11 (unique items)
S13         7   S5 OR S6 OR S8
S14         3   S13 NOT PY=>2000
S15         2   RD S14 (unique items)
S16         0   S4(S)S7
S17         3   S4(S)(DOWNSTREAM? OR UPSTREAM? OR (DOWN OR UP)()STREAM?)
S18         3   S17 NOT (S11 OR S13)
S19         0   S18 NOT PY=>2000
S20         3   RD S18 (unique items)
S21         0   S9(S)ETHERNET
S22         0   S9(S)ONU
S23         0   S9(S)EPON
```

12/3,K/1 (Item 1 from file: 9)
DIALOG(R)File 9:Business & Industry(R)
(c) 2002 Resp. DB Svcs. All rts. reserv.

02574141
La liaison rapide Normandie-Paris enfin sur les rails
(Fast train link between Paris and primary cities of Normandy is being planned; approximate cost will be FFr4.5 bil)
Echos, p 26
September 13, 1999
DOCUMENT TYPE: Business Newspaper (France)
LANGUAGE: French RECORD TYPE: Abstract

ABSTRACT:
...government, the Ile-de-France regional government, and the two Normandy regional governments. The time **frame** has yet to be agreed, although construction will begin during the period covered by the...

...in the Ile-de-France area, namely installing four tracks between Mantes-la-Jolie and **Epone** , a new line between **Epone** et Acheres, and a link between Saint-Lazare station, Paris, and the Eole network. This...

12/3,K/2 (Item 2 from file: 9)
DIALOG(R)File 9:Business & Industry(R)
(c) 2002 Resp. DB Svcs. All rts. reserv.

01501348 (USE FORMAT 7 OR 9 FOR FULLTEXT)
Merger mediators appointed
(Mediators are chosen to supervise upcoming restructuring of Dutch electricity sector)
European Energy Report, n 460, p 18
May 24, 1996
DOCUMENT TYPE: Newsletter ISSN: 0261-2259 (United Kingdom)
LANGUAGE: English RECORD TYPE: Fulltext
WORD COUNT: 500

ABSTRACT:
...investment fund and H Langman, a member of the supervisory board of regional electricity producer **EPON** . The four regional producers and their umbrella organization SEP will merge to create a single large-scale electricity company. A **framework** for this reorganization is supposed to be ready by end-1997. SEP thinks the merger...

12/3,K/3 (Item 1 from file: 484)
DIALOG(R)File 484:Periodical Abs Plustext
(c) 2002 ProQuest. All rts. reserv.

02826316 (USE FORMAT 7 OR 9 FOR FULLTEXT)
Glassner's Mesopotamian chronicles
Brinkman, J A
Journal of the American Oriental Society (PJOS), v115 n4, p667-670
Oct 1995
ISSN: 0003-0279 JOURNAL CODE: PJOS
DOCUMENT TYPE: Book Review-Favorable
LANGUAGE: English RECORD TYPE: Fulltext; Abstract
WORD COUNT: 3130 LENGTH: Long (31+ col inches)

TEXT:
... point to note the variant chronology in the Black Obelisk rather than to revise the **eponym** chronicles to fit the chronological **framework** of the other text.
30 The very small chronological chart (p. 269) is insufficiently detailed...

12/3,K/4 (Item 2 from file: 484)

DIALOG(R)File 484:Periodical Abs Plustext
(c) 2002 ProQuest. All rts. reserv.

02525813 (USE FORMAT 7 OR 9 FOR FULLTEXT)
Separation of caveolae from associated microdomains of GPI-anchored proteins
Schnitzer, Jan E; McIntosh, Deirdre P; Dvorak, Ann M; Jun Liu; Oh, Phil
Science (GSCI), v269 n5229, p1435-1439
Sep 8, 1995
ISSN: 0036-8075 JOURNAL CODE: GSCI
DOCUMENT TYPE: Feature
LANGUAGE: English RECORD TYPE: Fulltext; Abstract
WORD COUNT: 4147 LENGTH: Long (31+ col inches)

TEXT:
... agarose volume ratio of 1:3. The suspension was transferred by capillary action into a **frame** prepared from two glass slides separated at each end by two cover slips (0.17 mm thick). After cooling immediately to solidify the agarose, the **frame** was removed and the agarose cut into 2-mm squares, which were then incubated in...

...min each), incubated for 1 hour with 1% OsO sub 4 , dehydrated, and embedded in **Epon** . Ultrathin sections were cut, stained with 1% lead citrate, and viewed under a Philips P...

12/3,K/5 (Item 1 from file: 88)
DIALOG(R)File 88:Gale Group Business A.R.T.S.
(c) 2002 The Gale Group. All rts. reserv.

03625812 SUPPLIER NUMBER: 16929554
Hotel highs (and lows). (staying at fine hotels)(Pleasure & Its Perils)
Rusher, William A.
National Review, v47, n8, p48(2)
May 1, 1995
ISSN: 0028-0038 LANGUAGE: English RECORD TYPE: Fulltext; Abstract
WORD COUNT: 819 LINE COUNT: 00093

... afraid, for the Hotel Savoy in Cuzco, Peru. Any resemblance between this hostelry and its **eponym** on the Strand in London is strictly imaginary. It is 12,500 feet up on...

...a plate. Another feature of the Savoy was more endearing. Behind my door was a **framed** series of warnings on various subjects, posted there by the hotel staff and written in...

12/3,K/6 (Item 2 from file: 88)
DIALOG(R)File 88:Gale Group Business A.R.T.S.
(c) 2002 The Gale Group. All rts. reserv.

03513476 SUPPLIER NUMBER: 15959530
Tissue-specific targeting of retroviral vectors through ligand-receptor interactions.
Kasahara, Noriyuki; Dozy, Andree M.; Kan, Yuet Wai
Science, v266, n5189, p1373(4)
Nov 25, 1994
ISSN: 0036-8075 LANGUAGE: English RECORD TYPE: Fulltext; Abstract
WORD COUNT: 3368 LINE COUNT: 00268

... to delete the intervening envelope sequence and allow the EPO sequence to be inserted, in **frame** , at the [NH.sub.2]-terminal end of gp70. The EPO cDNA sequence coding for...

...could be inserted by means of the appropriate restriction sites while maintaining the proper reading **frame** . We also made a second construct containing EPO in the central portion of gp70 (between...conjugated swine antibody to goat IgG (CalTag) as the secondary antibody. (20.) Polyclonal

antiserum to **EPOno** . 8C295 (Amgen) and fluorescein-conjugated secondary antibodies (CalTag) were used for flow cytemetry, carried out...

12/3,K/7 (Item 3 from file: 88)
DIALOG(R)File 88:Gale Group Business A.R.T.S.
(c) 2002 The Gale Group. All rts. reserv.

02442506 SUPPLIER NUMBER: 08946633
Nutrition monitoring in the United States: an update report on nutrition monitoring; executive summary. (second report to Congress on the National Nutrition MOnitoring System)
Nutrition Today, v25, n1, p33(10)
Feb, 1990
ISSN: 0029-666X LANGUAGE: English RECORD TYPE: Fulltext
WORD COUNT: 6793 LINE COUNT: 00641

... assessment and surveillance of the food supply. The ad hoc Expert Panel on Nutrition Monitoring (**EPONM**) was established by the Life Sciences Research Office of the Federation of American Societies for...

...DHHS is the second report on the National Nutrition Monitoring System. It builds on the **framework** of the report developed by the Joint Nutrition Monitoring Evaluation Committee (JNMEC) in 1986.
CHARGE...

12/3,K/8 (Item 1 from file: 636)
DIALOG(R)File 636:Gale Group Newsletter DB(TM)
(c) 2002 The Gale Group. All rts. reserv.

03658984 Supplier Number: 47881430 (USE FORMAT 7 FOR FULLTEXT)
ELECTRICITY IN THE NETHERLANDS: BALANCING LIBERALISATION WITH DEFENCE
EC Energy Monthly, n104, pN/A
August 1, 1997
Language: English Record Type: Fulltext
Document Type: Magazine/Journal; Trade
Word Count: 2075

... electricity is traded in the Netherlands, other significant changes are occurring outside the proposed legal **framework** . In particular the Minister has pushed on with his desire to create a single united...

...producer - as a result of merging the four existing large producers, EPZ, EZH, UNA and **EPON** .
This entity, known as the GPB, will supply approximately 76% of national electricity requirements. As...

12/3,K/9 (Item 2 from file: 636)
DIALOG(R)File 636:Gale Group Newsletter DB(TM)
(c) 2002 The Gale Group. All rts. reserv.

02787157 Supplier Number: 45654777 (USE FORMAT 7 FOR FULLTEXT)
PRODUCT SIDEWIRE...
Telecomworldwire, pN/A
July 6, 1995
Language: English Record Type: Fulltext
Document Type: Newsletter; Trade
Word Count: 1176

... System to provide new object-orientated development facilities and applications for data warehouse applications... AXION **NETWORKS** has launched Lanservant Flexiprobe, a dual-port model for simultaneous RMON monitoring of two **Ethernet** LAN segments... EXTENDED SYSTEMS UK has announced its JetEye infra-red product range to support...

...VO) to allow Xbase users to move applications to a Windows client/server

environment... ANDREW **NETWORK** PRODUCTS has introduced Emerald Client for Windows, a 5250 emulator and file transfer client software...

...a new product for fast, flexible token ring bridging which can forward 18000 64-byte **frames** a second... DIGI INTERNATIONAL has introduced new ISDN WAN connectivity options through four products including ISDN terminal adaptors, **network** interfaces and group connectivity bridges... ARCHWAY INFORMATION TECHNOLOGY has launched Triticom Inc's, MasteRMON distributed **network** monitoring software which displays the activity of a selected **Ethernet** or Token-Ring LAN segment through the use of RMON agents... ANDREW **NETWORK** PRODUCTS has previewed its new Bridgeport/7712 compact MAU bridge, billed as a low-cost...

...unit ideal for satellite branch offices where space is limited but integration into the enterprise **networks** is essential -- the unit is an integrated bridge and **frame** relay switch in one box offering flexible operation in a single unit with seven ports...

...cleaner which is designed to ensure totally dirt and lint-free field connections for optimum **optical** signal transmission quality... XIRCOM EUROPE NV has cut the suggested retail price on the CreditCard **Ethernet** +Modem 2 PC Card Adapter by as much as 26% with the SRP of its...

...monitor with a UK RRP of GBP199 -- the unit has built -in fittings for optional **passive** speakers which clip on directly at either side of the monitor and following the curves...

...release of a XM534 module for its GigaHUB product family which provides store and forward **Ethernet** switching technology and FDDI backbone connectivity... **FRAME** COMMUNICATIONS LTD in the UK reports that its latest software release for RADCOM WAN/LAN analysers supports over 140 protocols and all popular interfaces... **FRAME** COMMUNICATIONS LTD, the distributor for Radcom (Rad-Group) has announced the availability of the 4/16Meg Token Ring Interface for the RC-100WL portable WAN/LAN analyser... **FRAME** COMMUNICATIONS LTD has announced DPNSS decode for its P.7. Series portable test equipment for...

...a new range of ISDN products that allow the integration of digital fines within existing **network** infrastructures... NOVELL has announced that PerfectOffice 3.0 buyers in the UK and Eire will...

...is not sponsored or endorsed by Microsoft Corp... MERCURY ONE-2-ONE, a UK PCN **network** operator, has cut the cost of its M150 handset to GBP49.99 on the business...

...Server which allows remote users to search and retrieve documents stored in their organisation's **network** document management system... K-NET, a UK **networking** integrator, has launched its CellStack Video stackable ATM adaption unit which allows multiple adaption devices...
...MAKE SYSTEMS in the UK has launched v.23 of its NetMaker XA suite of **network** decision tools with a new feature including plug-in functional toolsets and monitoring applications... RGB Trinet has launched the latest version of the **Network** Management System from US based Castle Rock Computing -- SNMPc version 4.0 -- a complete rewrite of code which offers substantially enhanced operation and functionality over earlier versions to automate **network** monitoring... CASTELLE INC has announced enhancements to its LANPress and JetPress line of print servers...

...users to configure an IP route for enhanced security when using edge routing techniques for **network** segmentation... HOLLAND HOUSE ...system with new features increasing operational power, ease-of-use and simplified licensing conditions... KENSON **NETWORK** ENGINEERING in the UK has introduced v2.0 of Netvix -- a **network** diagramming computer software package with new features including resource location, table form views, query facilities...

...real guarantee of performance on-site... PHOENIX DATACOM LTD in the UK is now offering **Network** General's new Database Module product which

allows the Sniffer **Network** Analyser and Distributed Sniffer System to optimise performance and aid management of distributed ORACLE7 relational
...

12/3,K/10 (Item 3 from file: 636)
DIALOG(R)File 636:Gale Group Newsletter DB(TM)
(c) 2002 The Gale Group. All rts. reserv.

02006907 Supplier Number: 43618452 (USE FORMAT 7 FOR FULLTEXT)
COMPOSITES INSTITUTE AWARDS BEST APPLICATIONS, PAPERS ON COMPOSITES
Composites Industry Monthly, n41, pN/A
Feb, 1993
Language: English Record Type: Fulltext
Document Type: Newsletter; Trade
Word Count: 586

... from designing space launch systems, a team of engineers at NASA-MFSC designed a T- **frame** monocoque racing wheelchair **frame** which weighs only 2.2 lb. Using AS4/12K and Shell's **Epon** 9405/ 9470, the **frame** consists of a filament-wound main tube which connects the composite tubular axle for the...

12/3,K/11 (Item 4 from file: 636)
DIALOG(R)File 636:Gale Group Newsletter DB(TM)
(c) 2002 The Gale Group. All rts. reserv.

01668908 Supplier Number: 42646503 (USE FORMAT 7 FOR FULLTEXT)
Dutch place order for major gas-fired power station
European Energy Report, pN/A
Jan 4, 1992
Language: English Record Type: Fulltext
Document Type: Newsletter; Trade
Word Count: 566

... relation to the fuel consumed - will make the new plant the most efficient in Europe, **Epon** says. The 109F unit incorporates the **Frame** 9F gas turbine, jointly developed by GEC Alsthom's subsidiary, European Gas Turbines, and General Electric of the US. According to GEC Alsthom, the **Frame** 9F is the most powerful gas turbine in the world. It is specifically designed for...
?

15/3,K/1 (Item 1 from file: 15)
DIALOG(R)File 15:ABI/Inform(R)
(c) 2002 ProQuest Info&Learning. All rts. reserv.

00923522 95-72914
Subscriber drop testing in a TR-909 FITL environment
Flaminio, Herman
Telephony v227n13 PP: 51-60 Sep 26, 1994
ISSN: 0040-2656 JRNL CODE: TPH
WORD COUNT: 2079

...TEXT: office terminal CU--Channel unit (Line unit) CTU--Channel test unit (MTAU) DCN--Data communications **network** DTH--Drop test head HDT--Host digital terminal IDLC--Integrated digital loop carrier IDT--Integrated digital terminal LMOS--Loop maintenance operating system LTF--Loop test **frame** (MLT-1) LTS--Loop test system (MLT-2) LU--Line unit (Channel unit) MCU--Metallic...

... unit (CTU) MUX--Multiplexer (DS-1 to DS-3 or higher) NTT--Numbered test trunk **ONU** -- **Optical network** unit PDN--Passive distribution **network** PGTC--Pair gain test controller PSN--Public switched **network** RT--Remote terminal RTU--Remote test unit SP--Signature presentation device TSI--Time slot interchanger...

15/3,K/2 (Item 2 from file: 15)
DIALOG(R)File 15:ABI/Inform(R)
(c) 2002 ProQuest Info&Learning. All rts. reserv.

00650740 92-65680
Fiber Rises to the Urban Challenge
Jander, Chris L.
Telephony v223n20 PP: 30-35 Nov 16, 1992
ISSN: 0040-2656 JRNL CODE: TPH
WORD COUNT: 1930

...TEXT: manage the bandwidth as required. If all 48 channels are not needed at a given **ONU** , **time slots** can be electronically assigned to appear at another location and thus eliminate the stranded bandwidth...
?

20/3,K/1 (Item 1 from file: 15)
DIALOG(R)File 15:ABI/Inform(R)
(c) 2002 ProQuest Info&Learning. All rts. reserv.

02022443 53813429
The hottest technologies
O Keefe, Sue; Masud, Sam; Boswell, Rebecca; Buckley, Sean
Telecommunications v34n5 PP: 32-40 May 2000
ISSN: 0278-4831 JRNL CODE: TEC
WORD COUNT: 5013

...TEXT: based service providers to support customers' multiservice needs.

Put simply a PON consists of an **optical** line terminal (OLT), which resides at the central office (CO) or a point of presence (POP), and an **optical network** terminal (ONT) located on or near the subscriber. The ONT provides the various service interfaces, such as **Ethernet** or DS1, to users. In the **downstream** path, a **passive optical** coupler, which can be located anywhere between the OLT and ONT, slices the light to serve as many as 32 end points and, in the **upstream** direction, combines the light. Some couplers might split the **optical** power evenly, others might do a directional split where, say, 90 percent of the power...

20/3,K/2 (Item 1 from file: 275)
DIALOG(R)File 275:Gale Group Computer DB(TM)
(c) 2002 The Gale Group. All rts. reserv.

02410169 SUPPLIER NUMBER: 62382397 (USE FORMAT 7 OR 9 FOR FULL TEXT)
The Hottest Technologies.(Technology Information)
Telecommunications, 34, 5, 32
May, 2000
ISSN: 0278-4831 LANGUAGE: English RECORD TYPE: Fulltext; Abstract
WORD COUNT: 5390 LINE COUNT: 00430

... multi-service needs.
2 PON: Sharing the Light
Put simply, a PON consists of an **optical** line terminal (OLT), which resides at the central office (CO) or a point of presence (POP), and an **optical network** terminal (ONT) located on or near the subscriber. The ONT provides the various service interfaces, such as **Ethernet** or DS1, to users. In the **downstream** path, a **passive optical** coupler, which can be located anywhere between the OLT and ONT, slices the light to serve as many as 32 end points and, in the **upstream** direction, combines the light. Some couplers might split the **optical** power evenly, others might do a directional split where, say, 90 percent of the power...

20/3,K/3 (Item 1 from file: 613)
DIALOG(R)File 613:PR Newswire
(c) 2002 PR Newswire Association Inc. All rts. reserv.

00724883 20020227SFW052 (USE FORMAT 7 FOR FULLTEXT)
Wave7 Optics Closes $23 Million Second Round of Financing
PR Newswire
Wednesday, February 27, 2002 07:44 EST
JOURNAL CODE: PR LANGUAGE: ENGLISH RECORD TYPE: FULLTEXT
DOCUMENT TYPE: NEWSWIRE
WORD COUNT: 1,103

TEXT:
Wave7 Optics, Inc., an innovative
developer of **optical** access equipment for the fiber-to-the-home and business
(FTTX) market, today announced that...

...will join the Wave7 board of directors.
Wave7 is developing a high-bandwidth, dynamically provisionable,

optical
access system to address the "last mile" of broadband Internet connectivity, a
market projected to reach $3.8 billion by 2004. Wave7's first suite of **optical**
access products, Last Mile Link(TM) effectively eliminates the current cost and implementation barriers faced by **network** operators in deploying Fiber-to-the-Home (FTTH) and Fiber-to-the-Business (FTTB) solutions...

...of funding will enable Wave7 to move its recently introduced Last Mile Link
suite of **optical** access products into the market, supporting the field trial
activity and full **network** deployment currently underway."
The Last Mile Link architecture is standards-based, cost-competitive with
current...

...fiber counts, limited distance range and high equipment costs of competing FTTX solutions, such as **passive** **optical** **networks** (PONs) in new
residential applications, and the Last Mile Link architecture is ideal in business...

...customers.
"Wave7 is enabling home and business users to finally realize the full advantages of **optical** access for video, high-speed data and telephony services
by addressing the core obstacles of...

...advantages over others in the industry trying to
address the lucrative 'last mile' of communications **networks** ."
Wave7 Optics' Last Mile Link advanced **optical** access system provides video
(CATV and digital, including IP streaming), high-speed data and telephony ...

...demand symmetrical data rates of up to 500 Mb/sec/subscriber, using standards-based Gigabit **Ethernet** on single fiber. When compared to conventional DOCSIS 1.1 standards for cable modems, which offer a peak **upstream** data capability of 10 Mb/sec and an average of .034 Mb/sec per sub...

...with the rapid progress Wave7
has made in deploying a system that can provision Gigabit **Ethernet** to the edge
of the metro **network** ," said Robert (Robin) Bellas, general partner at Morgenthaler. "With soon-to-be announced OEM and customer contracts, Wave7 is
set to capture the major opportunities that clearly exist in the **optical** access market."

About Wave7 Optics
Wave7 Optics, Inc., a privately held company headquartered in Alpharetta...

```
File  16:Gale Group PROMT(R) 1990-2002/Apr 25
         (c) 2002 The Gale Group
File 160:Gale Group PROMT(R) 1972-1989
         (c) 1999 The Gale Group
File  47:Gale Group Magazine DB(TM) 1959-2002/Apr 24
         (c) 2002 The Gale group
File  80:TGG Aerospace/Def.Mkts(R) 1986-2002/Apr 24
         (c) 2002 The Gale Group
File 148:Gale Group Trade & Industry DB 1976-2002/Apr 25
         (c)2002 The Gale Group
File 634:San Jose Mercury  Jun 1985-2002/Apr 24
         (c) 2002 San Jose Mercury News
File 635:Business Dateline(R) 1985-2002/Apr 26
         (c) 2002 ProQuest Info&Learning
File 647:CMP  Computer Fulltext 1988-2002/Apr W1
         (c) 2002 CMP Media, LLC
File 674:Computer News Fulltext 1989-2002/Apr W4
         (c) 2002 IDG Communications
File 810:Business Wire 1986-1999/Feb 28
         (c) 1999 Business Wire
File 696:DIALOG Telecom. Newsletters 1995-2002/Apr 25
         (c) 2002 The Dialog Corp.
File 813:PR Newswire 1987-1999/Apr 30
         (c) 1999 PR Newswire Association Inc

Set     Items   Description
S1         33   ETHERNET()PASSIVE()OPTICAL?()NETWORK?
S2        595   EPON??
S3     655764   FRAME?
S4        253   ETHERNET(S)PASSIVE(S)OPTICAL?(S)NETWORK?
S5          3   ONU(S)FRAME?(S)OPTICAL?(S)NETWORK?
S6          1   ONU(S)TIME()SLOTS
S7       1440   S3(S)(DOWNSTREAM? OR UPSTREAM? OR (DOWN OR UP)()STREAM?)
S8          1   (EPON OR EPONS OR ONU)(S)TIME(5N)SLOTS
S9         61   AU=(KUO J? OR KUO, J? OR GRUIA D? OR GRUIA, D? OR KRAMER G?
                OR KRAMER, G? OR PESAVENTO G? OR PESAVENTO, G?)
S10        28   (S1 OR S2 OR S4)(S)S3
S11         7   S10 NOT PY=>2000
S12         7   RD S11 (unique items)
S13         4   S5 OR S6 OR S8
S14         4   S13 NOT PY=>2000
S15         4   RD S14 (unique items)
S16         1   S4(S)S7
S17         6   S4(S)(DOWNSTREAM? OR UPSTREAM? OR (DOWN OR UP)()STREAM?)
S18         6   S17 NOT (S11 OR S13)
S19         0   S18 NOT PY=>2000
S20         5   RD S18 (unique items)
S21         0   S9(S)ETHERNET
S22         0   S9(S)ONU
S23         0   S9(S)EPON
```

12/3,K/1 (Item 1 from file: 16)
DIALOG(R)File 16:Gale Group PROMT(R)
(c) 2002 The Gale Group. All rts. reserv.

05163867 Supplier Number: 47881430 (USE FORMAT 7 FOR FULLTEXT)
ELECTRICITY IN THE NETHERLANDS: BALANCING LIBERALISATION WITH DEFENCE
EC Energy Monthly, n104, pN/A
August 1, 1997
Language: English Record Type: Fulltext
Document Type: Magazine/Journal; Trade
Word Count: 2075

... electricity is traded in the Netherlands, other significant changes are occurring outside the proposed legal **framework** . In particular the Minister has pushed on with his desire to create a single united...

...producer - as a result of merging the four existing large producers, EPZ, EZH, UNA and **EPON** .
This entity, known as the GPB, will supply approximately 76% of national electricity requirements. As...

12/3,K/2 (Item 2 from file: 16)
DIALOG(R)File 16:Gale Group PROMT(R)
(c) 2002 The Gale Group. All rts. reserv.

02049231 Supplier Number: 42646503 (USE FORMAT 7 FOR FULLTEXT)
Dutch place order for major gas-fired power station
European Energy Report, pN/A
Jan 4, 1992
Language: English Record Type: Fulltext
Document Type: Newsletter; Trade
Word Count: 566

... relation to the fuel consumed - will make the new plant the most efficient in Europe, **Epon** says. The 109F unit incorporates the **Frame** 9F gas turbine, jointly developed by GEC Alsthom's subsidiary, European Gas Turbines, and General Electric of the US. According to GEC Alsthom, the **Frame** 9F is the most powerful gas turbine in the world. It is specifically designed for...

12/3,K/3 (Item 1 from file: 47)
DIALOG(R)File 47:Gale Group Magazine DB(TM)
(c) 2002 The Gale group. All rts. reserv.

04371101 SUPPLIER NUMBER: 17489255 (USE FORMAT 7 OR 9 FOR FULL TEXT)
Separation of caveolae from associated microdomains of GPI-anchored proteins.
Schnitzer, Jan E.; McIntosh, Ann M.; Dvorak, Ann M.; Liu, Jun; Oh, Phil
Science, v269, n5229, p1435(5)
Sep 8, 1995
ISSN: 0036-8075 LANGUAGE: English RECORD TYPE: Fulltext; Abstract
WORD COUNT: 4492 LINE COUNT: 00366

... agarose volume ratio of 1:3. The suspension was transferred by capillary action into a **frame** prepared from two glass slides separated at each end by two cover slips (0.17 mm thick). After cooling immediately to solidify the agarose, the **frame** was removed and the agarose cut into 2-mm squares, which were then incubated in...

...each), incubated for 1 hour with 1% Os O.sub.4|, dehydrated, and embedded in **Epon** . Ultrathin sections were cut, stained with 1% lead citrate, and viewed under a Philips P...

12/3,K/4 (Item 2 from file: 47)
DIALOG(R)File 47:Gale Group Magazine DB(TM)

(c) 2002 The Gale group. All rts. reserv.

04166209 SUPPLIER NUMBER: 15959530 (USE FORMAT 7 OR 9 FOR FULL TEXT)
Tissue-specific targeting of retroviral vectors through ligand-receptor interactions.
Kasahara, Noriyuki; Dozy, Andree M.; Kan, Yuet Wai
Science, v266, n5189, p1373(4)
Nov 25, 1994
ISSN: 0036-8075 LANGUAGE: ENGLISH RECORD TYPE: FULLTEXT; ABSTRACT
WORD COUNT: 3411 LINE COUNT: 00268

... to delete the intervening envelope sequence and allow the EPO sequence to be inserted, in **frame** , at the [NH.sub.2]-terminal end of gp70. The EPO cDNA sequence coding for...

...could be inserted by means of the appropriate restriction sites while maintaining the proper reading **frame** . We also made a second construct containing EPO in the central portion of gp70 (between...conjugated swine antibody to goat IgG (CalTag) as the secondary antibody. (20.) Polyclonal antiserum to **EPOno** . 8C295 (Amgen) and fluorescein-conjugated secondary antibodies (CalTag) were used for flow cytemetry, carried out...

12/3,K/5 (Item 1 from file: 148)
DIALOG(R)File 148:Gale Group Trade & Industry DB
(c)2002 The Gale Group. All rts. reserv.

06486944 SUPPLIER NUMBER: 14010796 (USE FORMAT 7 OR 9 FOR FULL TEXT)
Eemscentrale GTCC station will generate 1675 MWe. (Netherlands gas-turbine combined-cycle power station) (includes fold-out wall chart)
Modern Power Systems, v13, n5, p43(4)
May, 1993
ISSN: 0260-7840 LANGUAGE: ENGLISH RECORD TYPE: FULLTEXT; ABSTRACT
WORD COUNT: 2960 LINE COUNT: 00252

TEXT:
Five 350 MWe gas turbine combined cycle power plant units of the latest **Frame** 9FA design will be installed at **EPON** 's Eemscentrale site on the northern coast of the Netherlands, close to the German border...
... all the mechanical and electrical equipment for the power train, including the five 350 MWe **Frame** 9FA combined cycle units, as well as performing the process and installation design in close co-operation with the project team of **EPON** , which will contribute their extensive operation and maintenance expertise.
For the exhaust heat recovery boilers...

12/3,K/6 (Item 2 from file: 148)
DIALOG(R)File 148:Gale Group Trade & Industry DB
(c)2002 The Gale Group. All rts. reserv.

01896135 SUPPLIER NUMBER: 02995068 (USE FORMAT 7 OR 9 FOR FULL TEXT)
No name, no fame for an important testing principle.
Soloway, Henry B.
Medical Laboratory Observer, v15, p21(2)
Nov, 1983
ISSN: 0580-7247 LANGUAGE: ENGLISH RECORD TYPE: FULLTEXT
WORD COUNT: 1348 LINE COUNT: 00112

... manner of testing, it is widely ignored. This is not surprising, for it lacks an **eponym** , and its title implies an inappropriate **frame** of reference.
Rather than being a narrow principle that refers to receivers, operators, or characteristics...

12/3,K/7 (Item 1 from file: 647)
DIALOG(R)File 647:CMP Computer Fulltext

(c) 2002 CMP Media, LLC. All rts. reserv.

01024318 CMP ACCESSION NUMBER: WIN19940101S4088
@col: Glossary of Network Terms
Jim Boyce
WINDOWS MAGAZINE, 1994, n 501 , 221
PUBLICATION DATE: 940101
JOURNAL CODE: WIN LANGUAGE: English
RECORD TYPE: Fulltext
SECTION HEADING: SOHO

TEXT:

AUI: Attachment Unit Interface, the 15-pin connector on an **Ethernet** card that allows the connection of a transceiver or media access unit. Bus: A **network** topology that places nodes along a straight line. 10Base2, for instance, is a bus topology. Dialup: A telephone connection used to access a host or **network** . 802.3: The Institute of Electrical and Electronic Engineers' (IEEE's) designation for **Ethernet** **networking** protocol. **Ethernet** : An extremely popular local area **networking** scheme that uses the CSMA/CD (Carrier Sense Multiple Access /Collision Detection) method to allow workstations to access the **network** . This can be compared to conversation at a crowded table. Carrier Sense listens for a...
...Collision Detection asks one individual to repeat if another party spoke at the same time. **Frame** : A data packet with defined fields, or specially defined groups of bits used for a...

...the address of a receiver. Hub: A common connection point for nodes in a star **network** topology. Hubs can be **passive** , requiring no external power, or active, requiring external power to perform functions such as amplifying...

...that have been weakened. Also called a concentrator. IPX: Internet Packet eXchange, part of the **networking** protocol used by Novell's NetWare. LAN: A local area **network** , a group of **network** nodes connected directly togetherQeither by cable, radio or laserQthat communicate directly with each other. MAU: Media access unit, a small box that fits on an **Ethernet** card's AUI connector. This allows it to connect to a medium other than thin coaxial cable, such as twisted pair cable or **optical** fiber. NDIS: **Network** Driver Interface Specification, Microsoft's specification for modular **network** drivers. NetDDE: Windows for Workgroups' ability to create DDE (Dynamic Data Exchange) links across the **network** . NetBIOS: **Network** Basic Input/ Output System, the **network** protocol used by Microsoft's LAN Manager **network** operating systems. NIC: **Network** interface card, an adapter card that plugs into a PC to connect it to the **network** media. ODI: Open Data-link Interface, Novell's specification for modular **network** drivers. PCMCIA: The initials for Personal Computer Memory Card International Association. This refers to the...

...of data that may be of any size but has some logical value in a **networking** scheme. Peer-to-Peer: A **network** in which workstations can be both clients and servers. The **network** services are provided by peers to each other. Ring: A **network** topology in which nodes are arranged in a circular configuration. Star: A **network** topology in which nodes are arranged in a pattern with a common origin , called a...

...hub. TCP/IP: Transmission Control Protocol/Internet Protocol, the protocol used on the InternetQa worldwide **network** of government, educational and industrial computer systems. 10Base2: The designation for the **Ethernet** protocol running on a thin coaxial cable, or thinnet. 10BaseT: The designation for the **Ethernet** protocol running on UTP (Unshielded Twisted Pair) cable, similar to telephone wiring. 10baseT requires concentrators with a port for each connected device. Thinnet: See 10Base2. Token Ring: A **networking** scheme championed by IBM in which a logical token is passed from a station to...
...transmit data only when in possession of the token. Topology: The physical configuration of a **network** (such as star or ring) or the logical arrangement of types of **networks** , such as **Ethernet** or token

ring.P UTP : Unshielded twisted pair, a type of cabling used in voice and data **networking** . Wireless: **Networking** using radio or infrared light, instead of cabling.
?t15/3,k/all

15/3,K/1 (Item 1 from file: 148)
DIALOG(R)File 148:Gale Group Trade & Industry DB
(c)2002 The Gale Group. All rts. reserv.

08244348 SUPPLIER NUMBER: 17490296 (USE FORMAT 7 OR 9 FOR FULL TEXT)
AT&T lifts 'CAP' to video. (AT&T Microelectronics' Access series of switched digital-video ICs uses Carrierless Amplitude-modulation/Phase-modulation encoding technology) (Product Announcement)
Wirbel, Loring
Electronic Engineering Times, n868, p18(2)
Oct 2, 1995
DOCUMENT TYPE: Product Announcement ISSN: 0192-1541 LANGUAGE: English RECORD TYPE: Fulltext; Abstract
WORD COUNT: 598 LINE COUNT: 00050

...ABSTRACT: Carrierless Amplitude-modulation/Phase-modulation (CAP) encoding technology. Switched digital-video uses fiber to neighborhood **optical networking** units (**ONU**) that send signals to homes via coaxial or twisted-pair cable. AT&T has joined...

...switched digital-video. The new Access series includes seven devices: the T7666 quad STS-1 **framer** and descrambler, T7665 QPSK receiver, and T7664 CAP-16 transmitter for the **ONU** ; and the T7660 CAP receiver, T7661 analog front end and QPSK transmitter, T7663 segmentation/reassembly and ATM adaptation layer processor, and T7662 set-top **framer** with SAR/AAL interface for the set-top box.

15/3,K/2 (Item 2 from file: 148)
DIALOG(R)File 148:Gale Group Trade & Industry DB
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08009504 SUPPLIER NUMBER: 16731034 (USE FORMAT 7 OR 9 FOR FULL TEXT)
E/O Networks aims to bring 'fiber to the farm.' (E/O Networks Inc develops an FDDI-like dual-ring fiber network for rural telephone companies)
Wirbel, Loring
Electronic Engineering Times, n838, p18(1)
March 6, 1995
ISSN: 0192-1541 LANGUAGE: English RECORD TYPE: Fulltext; Abstract
WORD COUNT: 617 LINE COUNT: 00051

ABSTRACT: E/O **Networks** Inc develops an FDDI-like dual-ring fiber **network** for rural telephone companies and intended to provide farms with a broadband service infrastructure. Regional...

...fining RBOCs for ignoring basic service gaps in rural areas as they focus on adding **frame** relay and ATM in urban corporate markets. Newcomer PTI Communications Inc has acquired many eastern...

...provide rural customers with analog service that accommodates V.34 modems. E/O's multiplexing **optical network** unit (**ONU**) hardware platform is based on an E1 (2.048-Mbps) backplane; a dual counter-rotating ...

15/3,K/3 (Item 3 from file: 148)
DIALOG(R)File 148:Gale Group Trade & Industry DB
(c)2002 The Gale Group. All rts. reserv.

07536272 SUPPLIER NUMBER: 16137937 (USE FORMAT 7 OR 9 FOR FULL TEXT)
Subscriber drop testing in a TR-909 FITL environment. (Bell Communications Research Inc. document; fiber in the loop) (includes glossary)

Flaminio, Herman
Telephony, v227, n13, p51(5)
Sept 26, 1994
ISSN: 0040-2656 LANGUAGE: ENGLISH RECORD TYPE: FULLTEXT; ABSTRACT
WORD COUNT: 2237 LINE COUNT: 00175

... office terminal CU Channel unit (Line unit) CTU Channel test unit (MTAU) DCN Data communications **network** DTH Drop test head HDT Host digital terminal IDLC Integrated digital loop carrier IDT Integrated digital terminal LMOS Loop maintenance operating system LTF Loop test **frame** (MLT-1) LTS Loop test system (MLT-2) LU Line unit (Channel unit) MCU Metallic...

...unit (CTU) MUX Multiplexer (DS-1 to DS-3 or higher) NTT Numbered test trunk **ONU Optical network** unit PDN Passive distribution **network** PGTC Pair gain test controller PSN Public switched **network** RT Remote terminal RTU Remote test unit SP Signature presentation device TSI Time slot interchanger...

15/3,K/4 (Item 4 from file: 148)
DIALOG(R)File 148:Gale Group Trade & Industry DB
(c)2002 The Gale Group. All rts. reserv.

06184623 SUPPLIER NUMBER: 13254510 (USE FORMAT 7 OR 9 FOR FULL TEXT)
Fiber rises to the urban challenge. (fiber-optic telecommunication networks) (Cover Story)
Jander, Chris L.
Telephony, v223, n20, p30(4)
Nov 16, 1992
DOCUMENT TYPE: Cover Story ISSN: 0040-2656 LANGUAGE: ENGLISH
RECORD TYPE: FULLTEXT; ABSTRACT
WORD COUNT: 2109 LINE COUNT: 00165

... manage the bandwidth as required. If all 48 channels are not needed at a given **ONU , time slots** can be electronically assigned to appear at another location and thus eliminate the stranded bandwidth...
?t16/3,k/all

16/3,K/1 (Item 1 from file: 696)
DIALOG(R)File 696:DIALOG Telecom. Newsletters
(c) 2002 The Dialog Corp. All rts. reserv.

00779876
What's Making Waves in the Market
Fiber Optics News
November 5, 2001 VOL: 21 ISSUE: 42 DOCUMENT TYPE: NEWSLETTER
PUBLISHER: PHILLIPS BUSINESS INFORMATION
LANGUAGE: ENGLISH WORD COUNT: 848 RECORD TYPE: FULLTEXT

(c) PHILLIPS PUBLISHING INTERNATIONAL All Rts. Reserv.

TEXT:
...64 Kbps to 100 Mbps
over existing copper pairs. Ikanos' chipsets support long range fast **Ethernet**
(LRFE), **Ethernet** in the first mile (EFM), and very high bit rate digital subscriber line-discrete multi...

...up to 10 Mbps (EFM), eight ports of asymmetric VDSL-DMT
data rates (23 Mbps **downstream** and 1 Mbps **upstream**), four ports of symmetric
data rates at up to 25 Mbps (LRFE), or one port...
...from 64 Kbps to 25 Mbps (EFM, LRFE), asymmetric VDSL-DMT data rates (40 Mbps **downstream** and 9 Mbps **upstream**).

NetTest

20/3,K/1 (Item 1 from file: 16)
DIALOG(R)File 16:Gale Group PROMT(R)
(c) 2002 The Gale Group. All rts. reserv.

07505760 Supplier Number: 62382397 (USE FORMAT 7 FOR FULLTEXT)
The Hottest Technologies.(Technology Information)
Telecommunications, v34, n5, p32
May, 2000
Language: English Record Type: Fulltext Abstract
Document Type: Magazine/Journal; Trade
Word Count: 5017

... multi-service needs.
2 PON: Sharing the Light
Put simply, a PON consists of an **optical** line terminal (OLT), which resides at the central office (CO) or a point of presence (POP), and an **optical network** terminal (ONT) located on or near the subscriber. The ONT provides the various service interfaces, such as **Ethernet** or DS1, to users. In the **downstream** path, a **passive optical** coupler, which can be located anywhere between the OLT and ONT, slices the light to serve as many as 32 end points and, in the **upstream** direction, combines the light. Some couplers might split the **optical** power evenly, others might do a directional split where, say, 90 percent of the power...

20/3,K/2 (Item 1 from file: 674)
DIALOG(R)File 674:Computer News Fulltext
(c) 2002 IDG Communications. All rts. reserv.

097776
Point-to-Multipoint DWDM raises optical reach
Byline: JEFF GWYNNE
Journal: Network World Page Number: 29
Publication Date: November 26, 2001
Word Count: 626 Line Count: 62

Text:
... significant recurring monthly revenue streams. That ignores 90% of enterprise customers, however. The emergence of **Passive Optical Networking** (PON) makes it possible for carriers to deploy wavelength, multiwavelength and fractional wavelength services to...

... provide higher service levels as more customers embrace value-added services such as storage-area **networks** (SAN) and virtual LANs. The components of Lamda-PONPoint-to-Multipoint DWDM based on PON consists of these elements: * A DWDM switch collocated with an **Optical** Access Switch (OAS) in the central office.* An **Optical** Transponder or Intelligent **Optical** Terminals (depending on the rate of service) on the customer premises.* A PON between the central office and the customer premises. Among the key elements of a PON are the **passive** couplers and splitters deployed in the outside plant that combine or split the laser signal...

... point. Because these splitters and couplers are fiber, once the carrier installs the outside plant **network** , all changes and upgrades occur only at the endpoints. This eliminates the need and expense of making changes to the outside plant.The collocation of the DWDM switch and the **optical** access switch in the central office allows the transmission of fractional and dedicated wavelength services...

...customer. While this traffic travels through every splitter and coupler, and reaches all endpoints, each **optical** transponder is outfitted with a filter that only receives the signal that is intended for...

... service level. For customers receiving fractional wavelength offerings, service is originated and aggregated at the **optical** access switch in the central office, without involving the DWDM switch. The traffic then travels at a maximum speed of 622M bit/sec **downstream** along the PON and is terminated at each customer location by **optical** terminals equipped with

T-1 and **Ethernet** interfaces. Enterprise customers receiving fractional wavelength services have the option of choosing between 10M and...

20/3,K/3 (Item 2 from file: 674)
DIALOG(R)File 674:Computer News Fulltext
(c) 2002 IDG Communications. All rts. reserv.

096220
The standards effort is focusing on three areas:
Journal: Network World Page Number: 38
Publication Date: September 17, 2001
Word Count: 529 Line Count: 50

Text:
Long-distance, point-to-point **optical** **Ethernet** - The technical objective is to standardize operation of 1,000M bit/sec (1000BaseX) **Ethernet** over a single fiber (instead of a fiber pair) at a distance greater than or...

... new fiber-optic physical layer interface could be used to provide lower cost, single-mode **optical** interfaces, using half the amount of fiber currently required for Gigabit **Ethernet** at distances twice that currently specified by the standards. State-of-the-art 1300nm and...

... be leveraged to support this work. This will be a relatively minor enhancement to existing **Ethernet** , using technology that is generally considered to be low risk. This kind of connection would be most applicable to high-speed corporate **networks** .Voice-grade copper **Ethernet** - The technical objective is to support point-to-point distances greater than or equal to...

... that will meet this requirement. This activity will likely require more work than long-distance **optical** fiber, but in the true spirit of **Ethernet** it will "borrow" from past work. **Passive optical Ethernet** - Perhaps the most aggressive and controversial of the three topologies being considered, the **Ethernet** **Passive** **Optical** **Network** (EPON) technical objective is to develop an 802.3 compatible physical layer interface for operation...

... from work already done within the post, telegraph and telephone administration-sponsored Full Service Access **Network** (FSAN) consortium. A **passive** **optical** **network** (PON) uses a single fiber from the central-office head end (or other active location) to service 16 to 32 end points. The **optical** signal would be split by one or more " **passive** " splitters mounted midstream in the **network** . In this topology, any end point could "receive" **downstream** traffic from the head end at up to the full 1,000M bit/sec, but would have to share the " **upstream** " bandwidth with up to 32 other nodes, thus limiting its share to about 30M bit...

... have a lower-cost electronics structure, however, given the still declining cost of very inexpensive **Ethernet** switches, it is not entirely clear that this will continue to be the case. Unfortunately, unlike the ATM PONs defined in FSAN, **Ethernet** operation over point-to-multipoint **networks** is currently undefined. Architecturally, **Ethernet** interfaces today expect the underlying **network** to be based on either point-to-point links or a shared peer-to-peer...

20/3,K/4 (Item 3 from file: 674)
DIALOG(R)File 674:Computer News Fulltext
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095841
Get a positive ID on DDoS attackers
Mazu's TrafficMaster Inspector a good first step in identifying DDoS attacks.
Byline: MANDY ANDRESS

Journal: Network World Page Number: 55
Publication Date: August 27, 2001
Word Count: 1177 Line Count: 113

Text:
...the attack du jour as of late, they are still a strong threat to any **network** , providing the ability to cripple even the highest-bandwidth providers. Distributed DoS attacks are so...

... the best solution, but they must be manually implemented and they often also block legitimate **network** traffic. The distributed nature of the attack makes prevention virtually impossible because you never know where the next attack will come from. Mazu **Networks** ' TrafficMaster Inspector helps solve some of these problems by providing a way to identify distributed DoS attacks in real time on large, high-speed **networks** . While Inspector identifies distributed DoS attacks, it does not provide any assistance in filtering the identified attacks. (Mazu **Networks** ' Enforcer gateway, due later this summer, will provide this capability.) Inspector resides **upstream** at the core of the **network** infrastructure and passively observes all traffic entering or leaving the **network** . It can reside anywhere on the **network** , but works best near the first-level routers, where it can directly monitor traffic to and from the Internet. Inspector connects to the data path via a **passive optical** or copper splitter, which introduces no latency into the **network** and performs detailed analysis in real time. Other distributed DoS solutions (from companies such as Asta **Networks** and Arbor **Networks**) receive a sample of **network** traffic from routers for analysis. Inspector sits directly on the **network** connection and monitors all traffic, independent of the **network** routers for packet information. One reason Mazu's solution is so expensive ($100,000) is...

... such as payload. Inspector makes it difficult for an attacker to launch a surge of **network** traffic without introducing an anomaly that it is able to detect. This includes unusual variations...

... probe and the cluster head. Probes are individual sensors that can be distributed throughout a **network** to capture and analyze traffic. (They support up to eight Gigabit **Ethernet** links.) The cluster head is the master probe, or central reporting device. All probes report...

... head, which combines the data for a more thorough analysis and "big picture" of the **network** . Within an Inspector probe, three main components are at work: user-level Mazu module, Mazu...

...device driver optimizes packet processing, enabling Inspector to quickly and efficiently capture packets off the **network** . Initially, Inspector baselines typical **network** activity (which takes about 30 minutes), documenting what is "normal" for the particular environment. It learns and adapts over time to the unique patterns of the **network** and is better able to separate legitimate increases in traffic from spoofed traffic with malicious...

... avoid false positives, Inspector includes user-defined thresholds on up to eight aspects of the **network** traffic, including protocol levels and traffic flow, to trigger alerts at the first signs of...

...DoS attacks, and Inspector successfully identified each. We also created a sudden increase in legitimate **network** traffic to see if the Inspector could differentiate between legitimate and attack traffic, which it...
... reporting were accurate and informative. Based on our lab testing, Inspector is effective at analyzing **network** traffic and determining when distributed DoS attacks are occurring. Administration and reportingInspector administration is performed...

...monitoring and set system thresholds. With SNMP enabled, an alert can be sent via your **network** management system (which can then send e-mails or a page) when a distributed DoS...detail. ConclusionInspector is an effective solution to identify distributed DoS attacks in large carrier-class

networks . Starting at $100,000 for only monitoring and attack characterization, it is not a solution...

20/3,K/5 (Item 1 from file: 696)
DIALOG(R)File 696:DIALOG Telecom. Newsletters
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00779876
What's Making Waves in the Market
Fiber Optics News
November 5, 2001 VOL: 21 ISSUE: 42 DOCUMENT TYPE: NEWSLETTER
PUBLISHER: PHILLIPS BUSINESS INFORMATION
LANGUAGE: ENGLISH WORD COUNT: 848 RECORD TYPE: FULLTEXT

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TEXT:
...64 Kbps to 100 Mbps
over existing copper pairs. Ikanos' chipsets support long range fast **Ethernet**
(LRFE), **Ethernet** in the first mile (EFM), and very high bit rate digital subscriber line-discrete multi...

...up to 10 Mbps (EFM), eight ports of asymmetric VDSL-DMT
data rates (23 Mbps **downstream** and 1 Mbps **upstream**), four ports of symmetric
data rates at up to 25 Mbps (LRFE), or one port...
...from 64 Kbps to 25 Mbps (EFM, LRFE), asymmetric VDSL-DMT data rates (40 Mbps **downstream** and 9 Mbps **upstream**).

NetTest

Web site: http://www.nettest.com
Product name: CMA4000i
Type of product: **Optical** spectrum analyzer module for C- and L-band DWDM **networks**
Target customer: **Network** installers, operators and maintenance personnel
Pricing and availability: Price varies according to installation needs, a ...

...is available now.
Contact: Harry Mellott, 315/266-5051
Description: The CMA4000i offers a new **optical** spectrum analyzer module for C- and L-band DWDM **networks** , a 50 dB dynamic range **optical** time domain
reflectometer (OTDR) module and new testing capabilities that simplify a variety
of fiber testing applications.
The CMA4000i tests either long haul backbone **networks** or **passive optical**
networks (PONs). Building on the CMA4000's long-haul (120-250 km) testing capabilities, the CMA4000i provides new solutions for testing medium range metro
networks (40-120 km), and short range last-mile **networks** or PONs. For complete
system characterization, the CMA4000i can be equipped with a light source ...

...enables the location of breaks within the OTDR's dead zone or to identify
specific **optical** fibers within a cable.

PowerNetix

Web site:http://www.powernetixinc.com
Product name: 980nm pump module
Type of product: Single-mode pump module

INDUSTRY NEWS

Read more about fiber optics and the emerging Passive Optical Networks industry through articles and technical documents!

February 5, 2002
"A National Imperative: Universal Availability of Broadband by 2010"

A paper outlining the goals and objectives of the lobbying group, "TechNet" which is efforting to make broadband a national priority and to set a goal of making an affordable 100-megabits broadband connection available to 100 million American homes and small businesses by 2010.

CED Magazine - February 5, 2002
"Roseville Finishes Phase One of FTTH Rollout"

Just slightly behind its Q4 schedule, Roseville Telephone finished phase one of its fiber-to-the-home program in certain Roseville, Calif., neighborhoods.

January, 2002
"Surfing Faster with Fiber"

Bob Harrington has long been an Internet speed demon. Three years ago, the Palo Alto Angel investor signed up for cable modem service, letting him access the Net at speeds dozens fo times faster than traditional dial-up modems.

EBN Online - Janaury 31, 2002
"Telcos Warming to Fiber to the Home"

Deployment of broadband data piped over fiber into the home is moving ahead, according to the recently formed Fiber-to-the-Home Council. But cost remains a major obstacle that chipmakers could help surmount, the organization stressed.

CNN Money- January 18, 2002
"Optical Communications Move Steady Ahead"

THE PAST FIVE YEARS HASTE BEEN good to the fiber-optics industry. Internet expansion and increased construction of wide-area networks (WANs) and metropolitan-area networks (MANs) have kept the industry growing rapidly. Dozens of new companies have entered this arena, producing an amazing array of advanced components, modules, and systems to make optical networking faster, cheaper, and more accessible.

Nielsen/NetRatings - December 11, 2001
"Nielsen/NetRatings Puts U.S. Broadband Residential Market at 21 Million Users, 90% Annual Growth " (Adobe Acrobat PDF File)

Nielsen//NetRatings, a leading Internet audience measurement service, estimates that there were 21 million residential broadband Internet users in the

US during the month of November. This would represent a 20% penetration rate of the 106 million active Internet users in the US, according to Nielsen/NetRatings. The growth rate in the number of broadband users (90% for November 2000 to 2001) also far outpaces the overall growth for Internet use (11%).

Lightreading - November 1, 2001
"PON: The Dream is Alive"

Recent sparks of interest in passive optical networking (PON) may justify a reborn faith in this nascent market, despite the impatient cries of naysayers. PON equipment seeks to lower the cost of access networks by extending optical bandwidth without requiring more expensive "active" components...

Lightwave - October 22, 2001
"Fiber-to-the-Home to reach 2.65 million homes by 2006"

The FTTH market is expected to grow significantly in 2006, with a ramp-up beginning in 2005. Fiber-to-the-home (FTTH) systems in the United States will reach 2.65 million homes by 2006, with fiber-to-the-curb (FTTC) systems reaching another 1.9 million, according to KMI Corporation's latest report, Residential Broadband Access in the United States: Fiber-to-the-Curb and Fiber-to-the-Home. As of year-end 2001, FTTH and FTTC are expected to reach 89,000 and 915,000 homes, respectively. During this same time frame, annual deployment of FTTH is expected to increase from 66,000 in 2001 to 1.15 million homes in 2006 -- a 63 percent compound annual growth rate (CAGR), with FTTC expecting a more modest 15 percent CAGR from 130,000 homes in 2001 to 260,000 homes in 2006...

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CABA Quarterly - Autumn 2001
"CABA Home and Building Automation Quarterly"

Interesting news on FTTH from CABA's Autumn 2001 newsletter.

Lightreading.com - 10/29/2001
"PON: The Dream is Alive"

PON company and development report showing

players and issues in the PON market.

Bigpipe.com - 10//2001
"Vendors Form FTTH Council"

> Vendors of fiber-to-the-home (FTTH) solutions created the non-profit FTTH Council this summer to dispel misconceptions about the technology and promote its acceptance. "Fiber-to-the-home is a real solution with a reasonable cost," says Wave7 Optics' Jim Farmer, who was elected to the FTTH Council's board of directors and who also serves as CT's senior technology editor. "We think (FTTH) future-proofs your network much better than anything else that's around today."

Bigpipe.com - 10//2001
"GigE: Coming to a Neighborhood Near You?"

> New Gigabit Ethernet technology provides a substantial improvement over cable modem data rates, but very little fiber is being deployed to the home--making any play for market share in existing neighborhoods an expensive prospect at best. "Nobody has a way to transmit Gigabit Ethernet to the home with a hook-up that is available today," Lauri Vickers, Cahners In-Stat senior analyst, says. "You need fiber or Cat 5 copper, but the connections just aren't there."

Wallstreet Journal - 10/03//2001
"Funding Shifts to Reach the Last Mile" (requiresonline subscription to WJS)

> Even with the slowdown in spending on fiber-optics networks, venture-capital investors continue to spend to reach the last mile. The "last mile" has been elusive thus far. Much spending has gone to the so-called long-haul networks, the major routes that carry data and communications under oceans and across continents. But lost in this has been getting all the data into individual homes. The analogy is often made that the lack of thick pipes at the ends of the networks is like attaching a fire hose to a straw.

Network World Newsletter - 9/28//2001
"Lucent Sheds Product Lines" (entire article follows)
by Jim Duffy

> Lucent continues to shed product lines in an effort to reverse the company's sagging fortunes and return to profitability.
>
> The latest casualty is the MSC 25000, an ATM core switch that was positioned as the next-generation offering for Lucent's installed base of GX 550 and CBX 500 users–the old Cascade boxes. The MSC 25000, announced last June, was to go into beta this month and ship by year-end, but Lucent will now replace it with an IP/MPLS switch of unknown origin.
>
> Some believe it will be based on the NX64000 router Lucent obtained from its acquisition of Nexabit Networks 2 years ago, but Lucent won't say anything until it announces the product later this year.
>
> Lucent seems to be acknowledging that ATM's

sunset as the underpinning of converged multiservice voice, video and data networks, is fast approaching. The MSC 25000 was to offer users a slower, more gradual migration to IP/MPLS, but Lucent says its large service provider customers want it faster than they could get it in the MSC 25000.

The MSC 25000's demise follows Lucent's recent shuttering of the Chromatis optical transport product line, which was targeted at smaller service providers than the 30-odd globalscale carriers Lucent is now courting for its turnaround and survival. Lucent acquired Chromatis last year for $4.5 Billion, and much of its product line was the foundation for Lucent's recent Metropolis metro area dense wave division multiplexing and optical cross-connect rollout.

Seems Lucent is now killing products just a few months after announcing them as part of a "strategic" assault on a particular market, complete with an overarching framework, vision or marketecture. Chromatis and the MSC 25000 are the latest examples. Perhaps Lucent's next product announcement will give an indication of which product line is the next to be shelved. There must be easier, less-embarrassing ways to disclose these things. Then again, if your restructuring plan is being hammered out at the same time as products are being developed, there may be no way to predict internally when to shift gears...

Light Reading- 9/20//2001
"Optical Ethernet Rules"

In the current market gloom, one sector has bucked the run of bad news to emerge as a beacon of excitement and optimisim: optical Ethernet. According to the latest report from the Optical Oracle, Light Reading's subscription service, the penetration of optical Ethernet equipment and services is accelerating so quickly that sales will overtake those of Sonet equipment within five to ten years.

Builder - 8/28//2001
"BellSouth Leads the Way With Fiber to the Home"

BellSouth just finished year one of what it says is the world's first fiber-to-the-home trial, delivering high-speed internet to 40+ homes in the Atlanta suburb of Dunwood, GA. Though the trial doesn't have an official end date, BellSouth spokesperson, Brian Ford, predicts that the company will be using the technology to offer voice, video and data to homes in its service area within three years.

FTTH Council - 8/28//2001
"FTTH Council Elects New Leadership, Kick-Starts Broadband Initiatives; Broadband Opportunities Take Center Stage at FTTH Council's First Meeting"

Rochester, NY, Aug. 28/PRNewswire/--The Fiber to the Home (FTTH) Council's membership elected eight members to its Board of Directors at the organization's first meeting August 23 in Rochester, NY...

Network World Fusion News - 7/23//2001
"Report Touts Growth in Optical Access Networking Systems"

> In spite of the slowing economy and declining growth rates in the fiber optics industry, first mile fiber connections to m ulti-tenant office buildings remain a strong growth area according to Communications Industry Researchers (CIR), an optical marketing research and consulting firm basedi in Charlottesville, VA...

Network World Fusion News - 7/23//2001
"RBOCs dipping toes into metro Ethernet Pool" by Michael Martin

> During the past year, metropolitan Ethernet providers such as Yipes, Cogent, Telseon and IntelliSpace have made waves with business services ranging from 1MB/s to 1GB/s at prices significantly lower than those for traditional high-bandwidth connections such as T1s and T3s.

InfoWorld - 7/23//2001
"Interview with Tony Abate, Battery Ventures"

> InfoWorld:Is there any interest in network hardware anymore?
> Abate: If you ignore competition for a second on the equipment side, there is still demand for new eauipment that does things faster, better, cheaper. Traffic growth on all these networks is still growing at double digit rates...

FTTH Council - 7/20//2001
"Fiberoptic Industry Leasders Meet This Week to Elect FTTH Council Board, Discuss Broadband Issues"

> ROCHESTER, N.Y., Aug. 20 /PRNewswire/ -- The Fiber-to-the-Home (FTTH) Council will meet in Rochester, N.Y. for the first time on Thursday, August 23, beginning its initiatives to promote fiber optic broadband access throughout North America. Guest speaker Thomas Cohen, executive director of Americans for the Digital Bridge, will discuss FTTH issues and opportunities.

Yahoo Finance - 7/17//2001
"Ethernet Poised to Become UbiquitousStandard for Wireline Subscriber Access Networks"

> The Institute of Electrical and Electronics Engineers, Inc., (IEEE) 802 LAN/MAN Standards Committee (LMSC) today announced it has approved a Project Authorization Request (PAR) for Ethernet in the First Mile (EFM)...

CED - 3//2001
"FTTH Starts Making House Calls" by Michael Lafferty, CED Associate Editor

> While scientists and commentators are marveling at the recent success in mapping the vast complexities of the human genome, a small, but growing number of broadband service providers are taking a fresh look at the minute details of a delivery platform that was once considered pure fantasy...

MSNBC - 3/7//2001

"Net Telephony Shakes Up Industry" by Associated Press

> "INTERNET TELEPHONY means lower prices for consumers and big challenges for telecom operators," said U.N. official Tim Kelly, an organizer of a three-day meeting of 1,000 government regulators and industry experts that starts Wednesday...

TMCNet.com - 2/28/2001
"Voice Over Broadband is Ready to Roll" by Sean Parham

> For years, cable operators have been trying to find ways to better leverage their existing broadband infrastructure for new revenue opportunities. The $750 billion dollar voice services market has always been just beyond their reach. However, with the deregulation of the US telecom market in 1996, cable operators gained access to the PSTN (Public Switched Telephone Network)...

Interactive Week- 2/19/2001
"Shining Stars " by John T. Mulqueen

> Profits are coming hard to telecom carriers, with voice revenue shrinking and data not yet taking up the slack, but they're still buying optical equipment at a frenzied pace. That's very good news to optical equipment makers, which continue to...

Interactive Week- 2/12/2001
"New Lasers Will Speed Optical Networks" by Bill Scanlon

> This quarter, most large carriers are testing tunable lasers. These devices speed ones and zeroes down optical networks and jump from wavelength to wavelength faster than an eyeblink. The market for tunable lasers is expected to grow from $100 million last year to about $1.5 billion in the next couple of years, according...

Network Magazine- 2/12/2001
"Study Shows Growth in Otical Networking Market" by tele.com staff

> Fueled by the increasing needs of service providers for next-generation optical networking equipment, this market segment generated $9.2 billion in revenue in 2000 and is projected to jump to nearly $40 billion by 2005, says a report by Frost & Sullivan (San Jose, Calif.)...

Network Magazine- 2/5/2001
"Planning for Fast Optics" by Tom Nolle

> Squirrels used to bury acorns. Now they're likely burying fiber; if not, they're the only hole-diggers who aren't. There's a huge amount of glass going into the ground these days, promising a huge amount of bandwidth for the future. Network design today is based on the principle that transport bandwidth is the most expensive element in the network...

The Net Economy - 1/28/2001
"A Gateway to the Future" by Denise Culver

> Broadband Gateways hasn't had a difficult time

selling the first generation of its product to service providers including AT&T, BellSouth, SBC, Sprint and Verizon. For about $1,350, Broadband's product, a residential wireless gateway, lets service providers add up to eight additional phone numbers in a home–all with their own calling...

The Net Economy - 1/19/2001
"Deconstructing Ethernet " by Joe McGarvey

Underscoring the growing importance of the metropolitan portion of the public network, a group of network equipment veterans and startups this week launched an industry alliance around a fledgling protocol designed to improve data performance in the metro network...

X-Change Magazine - 1/2001
"Heading Toward the Light : Startups Leap into Optical IP Space" by Paula Bernier

The packet-over-optics vendor space continues to expand, with the industry birthing new companies and products faster than a rabbit makes bunnies....

Broadband Week- 12/2000
"I Want My Broadband Download" by Matt Stump

Fifteen years ago, "I Want My MTV" was considered the frontier of music. Today, with Napster and MP3.com, it's broadband connections that represent both a promise and a threat to the big five music labels...

Network Magazine- 11/27/2000
"Fiber Home Economics" by Brian Washburn

Local service providers dazzled customers with promises of fiber to the home (FTTH) years ago. But twisted-pair and coaxial cable still reign supreme in the neighborhood, even though providers are moving closer and in some cases even laying fiber as close as the curb. With the promise of broadband, FTTH economics may finally make sense...

Network Magazine- 11/5/2000
"Passive Optical Networking Brings DSL to the Masses" by Doug Allen

The most important event in the short history of Digital Subscriber Line (DSL) is upon us: The Incumbent Local Exchange Carriers (ILECs) are finally about to begin massive deployment of broadband access links, after years of stalling and halfhearted efforts. Not to dismiss the million-odd RBOC DSL lines in service, but bandwidth to the masses it ain't...

Network Magazine- 11/5/2000
"Passive Optical Networks in Action" by Mark Lutkowitz

Although Passive Optical Networks (PONs) have lately received much exposure at telecom trade shows and in the press, it is unclear to what extent the technology will penetrate the edges of telecom provider networks. PONs offer a number of advantages, such as very low cost, for small to

medium-size businesses...

The Fiber Exchange - 9/27/2000
"So Many PONs, So Little Market?" by Stephen Hardy

> Someday, nearly every home and business will send and receive voice, data, and video over a fiber-optic cable that reaches right to the front door. Of course, a cartoon character once sang that someday her prince would come. Based on the costs traditionally associated with fiber in the access space-and the amount of investment the biggest players in that space...

Multichannel News Online - 9/21/2000
"Scientific Atlanta Eyes Fiber-to-the-Home with Alloptic" by David Iler

> With its sights set on developing next-generation network architectures, Scientific-Atlanta Inc. recently invested $8 million in Pleasanton, Calif.-based Alloptic Inc., a developer of passive-optical-networking technologies.

EE Times.com- 1/16/2000
"Ethernet Tapped for Passive Transport" by Loring Wirbel

> 01/16/01, 6:33 p.m. EST) SANTA CLARA, Calif. Ð Alloptic Inc., the latest entrant in the passive optical-network (PON) access markets, is proposing the use of Ethernet framing as a pure passive transport technology, bringing Gigabit Ethernet services to homes and businesses through a PON-based optical network unit architecture...

Scientific American- 10/3/1999
"PON, The Broadest Broadband" by Paul W. Shumate, Jr.

> Optical fiber has successfully replaced metallic cables in the backbone networks of most local and long-distance telephone carriers, cable television operators and utility companies. So why not extend lines of optical fiber all the way to customers' homes?

CED Communications Engineering and Design - 9/1999
"Lighting up the Neighborhood" by Roger Brown and David Iler

> Recent advances in optical technology are rapidly making possible something that just a couple of years ago was considered unthinkable: The deployment of fiber to nodes so small that the network has become almost entirely passive, and fiber is pushed so close to the home that consumers can nearly reach out and touch it...

Lightwave - 9/1999
"PONs for the Broadband Local Loop" by Gerry Pesavento and Mark Kelsey

> Deregulation and bandwidth-hungry applications are creating unprecedented opportunities to develop the local-access network. The bandwidth bottleneck in the local loop continues to slow Internet access to a crawl, frustrating end users and reducing the revenue-earning potential of communications service providers...

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ID (25) ETHERNET, FRAME RELAYS, PASSIVE OPTICAL NETWORKS, SONET(SYNCHRONOUS OPTICAL NETWORK)
AB (27) As the field of computer networking has evolved, so too has the use of these networks. Modern networks must be capable of performing more than simple data transfer. To be of value, a network must be able to handle the convergence of different types of traffic: voice, video, and data; and the Quality of Service requirements associated with each type. This thesis performs a detailed analysis of the different types of traffic, the two primary transmission media, fiber optical and copper based connections, and the connection-orientation technology to route the traffic. Presented in this thesis is a fiber-based hybrid network consisting of Asynchronous Transfer Mode at the backbone layer and Frame Relay and Passive Optical Networking at the local access layer. The proposed Universal Traffic Network, based on present-day technology, is a viable solution to the challenge imposed by the convergence of different traffic types.

IPACT: A Dynamic Protocol for an Ethernet PON (EPON)

Glen Kramer and Biswanath Mukherjee, University of California, Davis
Gerry Pesavento, Alloptic, Inc. Livermore

ABSTRACT

We investigate design issues for access networks based on passive optical network technology. A PON based on polling, with data encapsulated in Ethernet frames, possesses many desirable qualities, such as dynamic bandwidth distribution, use of a single downstream and a single upstream wavelength, ability to provision a fractional wavelength capacity to each user, and ease of adding a new user. To support dynamic bandwidth distribution, we propose an interleaved polling algorithm called IPACT. We also suggest a scheme for in-band signaling that allows using a single wavelength for both downstream data and control message transmission. To obtain realistic simulation results, we generated synthetic traffic that exhibits the properties of self-similarity and long-range dependence. We then analyzed the network performance under varying offered loads.

INTRODUCTION

Passive optical network (PON) is a technology viewed by many as an attractive solution to the last mile problem [1, 2]. A PON is a point-to-multipoint optical network with no active elements in the signals' path from source to destination. The only interior elements used in PON are passive combiners, couplers, and splitters.

Advantages of using PON for a subscriber access network include large coverage area, reduced fiber deployment, multicast and broadcast capabilities, reduced cost of maintenance (due to devices being passive), and ease of upgrades to higher bit rate or additional wavelengths.

The work of standardizing Ethernet PON (EPON) as a solution for access networks is ongoing in the IEEE 802.3ah Ethernet in the First Mile (EFM) Task Force. The group's focus is on ensuring interoperability by specifying parameters and operations of physical and data link layers. Particular bandwidth allocation algorithms are considered to be vendor-specific and outside of scope of the task force. In this study we describe a new dynamic bandwidth allocation algorithm and analyze its performance in an EPON.

In [3] we discussed the advantages of using time-division multiple access (TDMA) in a PON, namely the scalability and ability to provide a fraction of a wavelength capacity to a user, a single wavelength for all upstream channels, a single receiver in the head-end, and so on. However, we also showed that a considerable amount of bandwidth was wasted due to time slots not being filled to capacity. To make the cost of a PON-based access network lower, it is very important to utilize bandwidth efficiently.

In this study we present a new protocol called Interleaved Polling with Adaptive Cycle Time (IPACT, pronounced *eye-pact*). The PON-based network under consideration uses a polling scheme to deliver data encapsulated in Ethernet packets from a collection of optical network units (ONUs) to a central optical line terminal (OLT) over the PON access network. The OLT, in turn, is connected to the rest of the Internet.

To avoid the accumulation of walk times (switchover times) associated with polling, we employ an *interleaved* scheme where multiple polling requests are overlapped in time. We then discuss an efficient way to use in-band control signaling to perform the polling.

We present simulation results to demonstrate system performance such as bounds on packet delay, queue occupancy, and packet-loss probability.

DESIGN OF AN ACCESS NETWORK BASED ON PON TECHNOLOGY

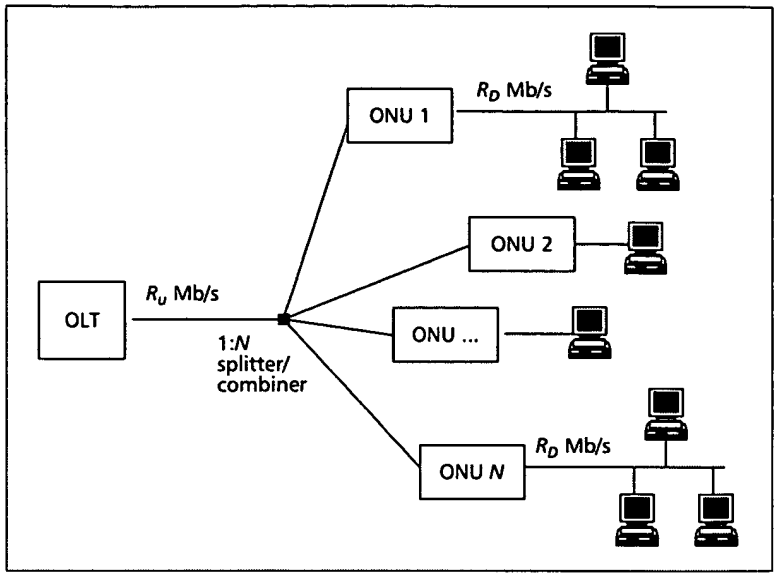
Figure 1 shows a typical tree-based PON topology suitable for the access network. Other PON topologies include a ring and a bus. A PON can also be deployed in a redundant configuration as a double ring or a double tree. All transmissions in a PON are performed between OLT and ONUs. Therefore, in the downstream direction

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(from OLT to ONUs), PON is a point-to-multipoint network, and in the upstream direction it is a multipoint-to-point network.

The OLT resides in the local exchange (central office), connecting the optical access network to an IP, ATM, or SONET backbone. The ONU is located at either the curb (FTTC solution), or the end-user location (FTTH, FTTB solutions), and provides broadband voice, data, and video services.

The Full Service Access Network (FSAN) standard defines an optical access network that uses asynchronous transfer mode (ATM) as its transport protocol. However, ATM equipment is significantly more expensive than Ethernet [4]. Thus, FSAN's future, relying on ATM transport, looks rather grim. EPONs, on the contrary, appear to be the preferred choice. Newly adopted quality of service (QoS) techniques have made Ethernet networks capable of supporting voice, data, and video. Ethernet is an inexpensive technology that is interoperable with a variety of legacy equipment. In this study we will focus on EPONs.



■ **Figure 1.** *A typical access network based on tree PON topology.*

Channel Multiplexing

Because Ethernet is broadcast by nature, in the downstream direction (from network to user) it fits perfectly with the EPON architecture: packets are broadcast by the OLT and extracted by their destination ONU based on the media access control (MAC) address.

In the upstream direction (from user to network), the ONUs should share the channel capacity and resources. We believe the TDMA approach is a preferred method of channel sharing in an access network since it allows using a single upstream wavelength and results in a very cost-effective solution. However, in [3] we also showed the limitation of TDMA approach: the lack of statistical multiplexing.

The burstiness of network traffic results in a situation where some time slots overflow even under very light load, resulting in packets being delayed for several time slot periods. It is also true that some time slots remain underutilized (not filled completely) even if the traffic load is very high. This leads to the PON bandwidth being underutilized.

A dynamic scheme that reduces the time slot size when there is no data would allow the excess bandwidth to be used by other ONUs. The challenge of implementing such a scheme is in the fact that the OLT doesn't know exactly how many bytes of data each ONU has.

Below we present an OLT-based polling scheme, similar to hub polling [5]. Our algorithm uses an interleaved polling approach where the next ONU is polled before the transmission from the previous one has arrived. This scheme provides statistical multiplexing for ONUs and results in efficient upstream channel utilization.

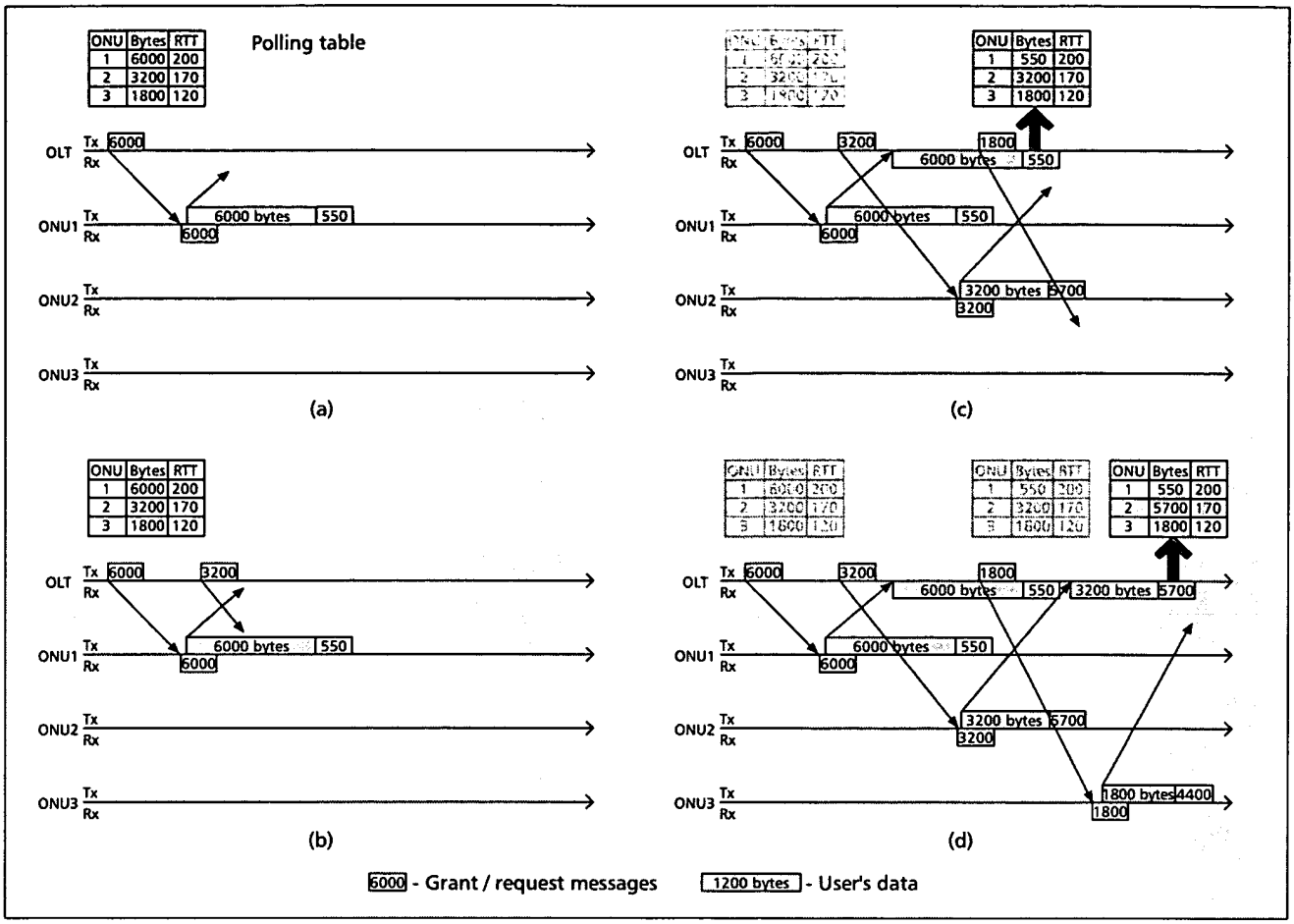
Interleaved Polling with Adaptive Cycle Time

In this section we give a high-level overview of the proposed algorithm. For simplicity of illustration, we will consider a system with three ONUs:

1. Assume that at some time t_0 the OLT knows exactly how many bytes are waiting in each ONU's buffer and the round-trip time (RTT) to each ONU. OLT keeps this data in a polling table, shown in Fig. 2a. At time t_0 the OLT sends a control message to ONU1, allowing it to send 6000 bytes (Fig. 2a). We call such a message a *Grant*. Since, in the downstream direction, the OLT broadcasts data to all ONUs, a Grant should contain the ID of the destination ONU, as well as the size of the granted window (in bytes).
2. Upon receiving the Grant from the OLT, ONU1 starts sending its data up to the size of the granted window (Fig. 2b), in our example up to 6000 bytes. At the same time the ONU keeps receiving new data packets from users. At the end of its transmission window, ONU1 will generate its own control message (*Request*). The Request sent by ONU1 tells the OLT how many bytes were in ONU1's buffer at the moment the Request was generated. In our case there were 550 bytes.
3. Even before the OLT receives a reply from ONU1, it knows when the last bit of ONU1's transmission will arrive. This is how OLT knows it:

 (a) The first bit will arrive exactly after the RTT time. The RTT in our calculation includes the actual RTT, Grant processing time, and a preamble for the OLT to perform bit and byte alignment on received data, that is, exactly the time interval between sending a Grant to an ONU and receiving data from the same ONU.

 (b) Since the OLT knows how many bytes (bits) it has authorized ONU1 to send, it knows when the last bit from ONU1 will arrive. Then, knowing RTT for ONU2, the OLT can schedule a Grant to ONU2 such that the first bit from ONU2 will arrive soon after the last bit from ONU1, with only a small guard interval in between (Fig. 2b). The guard intervals provide protection for fluctuations of RTT and control message processing time of various ONUs. Additionally, the OLT receiver needs some



■ **Figure 2.** *Steps of the Polling Algorithm.*

time to readjust its sensitivity due to the fact that every ONU is located at a different distance from the OLT (far-near problem).

4. After some time, the data from ONU1 arrives. At the end of the transmission from ONU1, there is a new Request that contains information on how many bytes remained in ONU1's buffer when the Request transmission began. The OLT will use this information to update its polling table (Fig. 2c). By keeping track of times when Grants are sent out and data is received, the OLT constantly updates the RTT entries for the corresponding ONUs.
5. Similarly to the above step, the OLT can calculate the time when the last bit from ONU2 will arrive. Hence, it will know when to send the Grant to ONU3 so that its data is tailed to the end of ONU2's data. After some more time, the data from ONU2 will arrive. The OLT will again update its table, this time the entry for ONU2 (Fig. 2d).

Note that if an ONU emptied its buffer completely, it will report 0 bytes back to the OLT. Correspondingly, in the next cycle, the ONU will be granted 0 bytes, that is, it will be allowed to send a new Request, but no data.

It should be clear from the above description that there is no need to synchronize the ONUs, nor is there a need to perform a ranging (making ONUs to appear equidistant from the OLT by delaying the response from ONUs by a specific amount of time) traditionally employed in TDMA schemes. Every ONU executes the same procedure driven by the Grant messages received from the OLT. The entire scheduling and bandwidth allocation algorithm is located in the OLT. Thus, it is easy to adaptively change the scheduling at run-time based on some network conditions; the ONUs don't need to negotiate or acknowledge new parameters, nor do they need to switch to new settings synchronously.

In the above algorithm, we started with the OLT already having its table populated. During system initialization, since round-trip times are unknown, OLT should poll each ONU one at a time. The reader is referred to [6] for a detailed description of cold start and ONU initialization procedures.

Control-Message Format — The Request and Grant messages should only contain two pieces of information: ONU's node identification (NID) and requested/granted window size (WS). Format of control messages may have high impact on overall system performance. For example, if the control messages are encapsulated in Ethernet frames, the two problems become apparent:

- Grant blocking behind long downstream frame increases guard band and consequently degrades upstream utilization.

- In case of asymmetric load (high downstream load and light upstream load) cycle time becomes very short, which results in more frequent Grants consuming more downstream bandwidth.

Fortunately, another solution is available. First, we note that an Ethernet frame with its 64-byte minimum size is overkill for a control message consisting only of 1-byte NID and 2-byte WS fields. The solution we propose is to embed the Grant messages inside the downstream data packets using escape sequences. To understand this approach, first recall that Ethernet uses 8-to-10 bit encoding as defined by IEEE standard 802.3. However, not all of 10-bit values are valid encoding of an 8-bit value. One or more of these "non-valid" codes can be chosen to represent an escape code. Thus, the control message (either Grant or Request) will be 4 bytes long and will consist of 1-byte escape code (ESC), 1-byte node ID value, and 2 bytes of window size. Such a control message can be inserted in the middle of an Ethernet frame or between the frames. The receiver will recognize the beginning of the embedded control sequence by reading the ESC code. It will then extract the 3 bytes that follow the ESC byte before passing the rest of the received data to a standard Ethernet MAC.

Upstream control messages (Requests) will use the same 4-byte format and they will be sent at the end of the transmission from a given ONU.

Scheduling a Control Message — Grants are always scheduled one cycle ahead. The objective of Grant scheduling is to achieve a situation when transmissions from all ONUs arrive at OLT in order and without overlaps (collisions). In fact, to allow the receiver in the OLT adjust to a new power level and synchronize on new bit/byte boundary, we require a minimum gap (guard time) between transmissions from deferent ONUs.

The Grants are scheduled with regard to the corresponding round-trip times and granted window sizes. As a result, the order of Grants may be different in every cycle. Scheduling the Grant to ONU $i+1$ ahead of the Grant to ONU i is not a problem as the order of Grants is determined in a cycle prior to when they should be transmitted.

Scheduling the Grants as described above may result in a Grant scheduling conflict. The conflict occurs when two Grants are scheduled less than a Grant transmission time apart. Adapting to the message format described above and assuming a transmission speed of 1 Gb/s, the Grant transmission time is equal to 32 ns. To resolve such a conflict, the Grant that is scheduled last should be delayed till the end of transmission of the previous Grant. Grant delay has no significant effect on system performance; the only consequence of it is the corresponding delay of transmission from the ONU (i.e., increase of the guard time before that transmission). Of course, after the conflicting Grant is delayed, it may collide again with another Grant that was scheduled before. In the extreme case, some Grant may collide with at most $N - 1$ other Grants, where N is the number of ONUs. For the case of $N = 16$, the maximum acquired delay is 0.48 μs. Obviously, this solution does not introduce any scalability issues in terms of the value of N because multiple collisions only negligibly increase the guard time.

Maximum Transmission Window — If the OLT authorizes each ONU to send its entire buffer contents in one transmission, ONUs with high data volume could monopolize the entire bandwidth. To avoid this situation, the OLT will limit the maximum transmission size: every ONU gets a Grant to send as many bytes as it has requested, but no more than some limit (maximum transmission window size). There could be various schemes for specifying the limit. It can be fixed, say, based on a Service Level Agreement (SLA) for each ONU, or dynamic — based on network conditions. Let us denote an ONU-specific maximum transmission window size $W_{MAX}^{[i]}$. The choice of specific values of $W_{MAX}^{[i]}$ determines the maximum polling cycle time T_{MAX} under heavy load conditions. Making T_{MAX} too large will result in increased delay for all the packets, including high-priority (real-time) packets. Making T_{MAX} too small will result in more bandwidth being wasted by guard times.

Also, the $W_{MAX}^{[i]}$ value determines the guaranteed bandwidth available to ONU-i, that is, the ONU is guaranteed to be able to send $W_{MAX}^{[i]}$ bytes in at most T_{MAX} time. Of course, an ONU's bandwidth will be limited to its guaranteed bandwidth only if all other ONUs in the system also use all their available bandwidth. If at least one ONU has less data, it will be granted a shorter transmission window, thus making the cycle time shorter, and therefore the available bandwidth to all other ONUs will increase proportionally to their $W_{MAX}^{[i]}$. This is the mechanism behind dynamic bandwidth distribution: by adapting the cycle time to the instantaneous network load (i.e., queue occupancy), the bandwidth is automatically distributed to ONUs based on their loads.

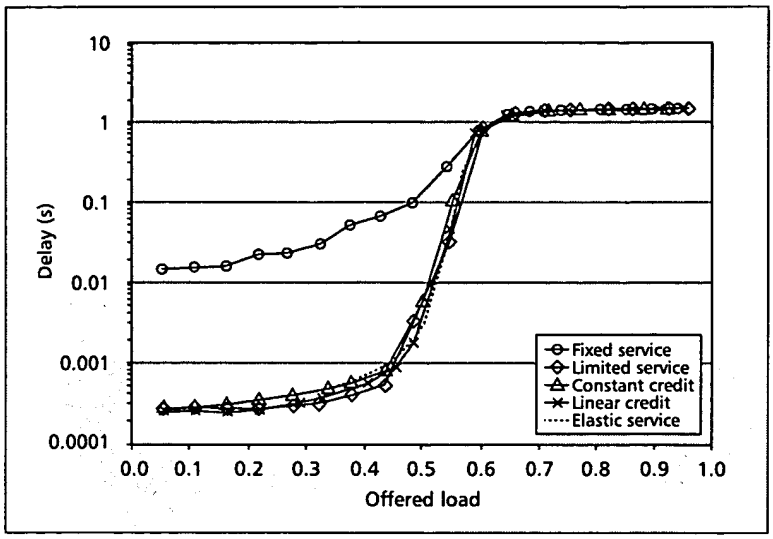
In our simulations we assume that all ONUs have the same maximum transmission window, that is, $W_{MAX}^{[i]} = W_{MAX}$, $\forall i$. We believe $T_{MAX} = 2$ ms and guard time of 5 μs are reasonable choices. That made $W_{MAX} = 15{,}000$ bytes. With that choice of parameters, every ONU will get a guaranteed bandwidth of 60 Mb/s. It can be shown that when only one ONU has data to send, the maximum bandwidth available to that ONU is 600 Mb/s [6].

The remaining question is how the OLT should determine the granted window size if the requested window size $W^{[i]} < W_{MAX}$. Below we describe a few approaches the OLT may employ in making its decision.

Fixed service ignores the requested window size and always grants the maximum window. As a result it has a constant cycle time T_{MAX}. Essentially this approach corresponds to the fixed TDMA PON system [3]. It is shown here only for comparison.

Limited service grants the requested number of bytes, but no more than W_{MAX}. It is the most conservative scheme and has the shortest cycle of all the schemes.

The Grants are scheduled with regard to the corresponding round-trip times and granted window sizes. As a result, the order of Grants may be different in every cycle.



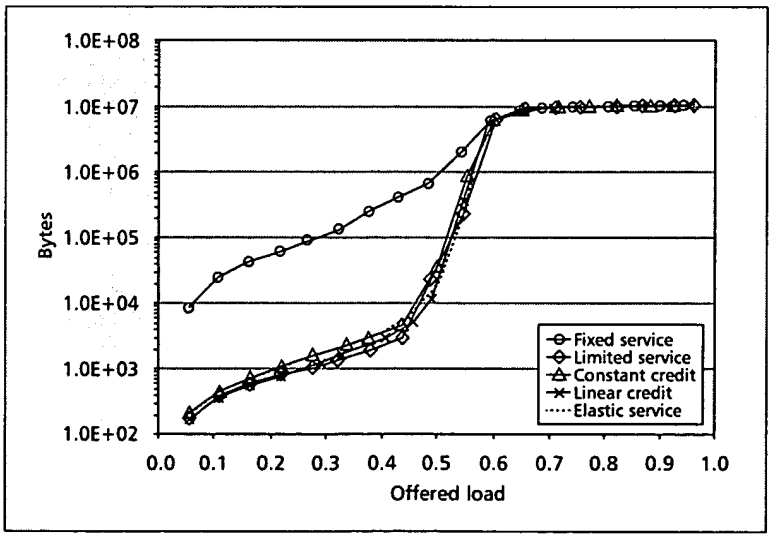
■ **Figure 3.** *Mean packet delay.*

The *Constant Credit* scheme adds a constant credit to the requested window size. The idea behind adding the credit is the following: assume x bytes arrived between the times an ONU sent a Request and received the Grant. If the granted window size equals requested window + x (i.e., it has a credit of size x), these x bytes will not have to wait for the next Grant to arrive; they will be transmitted with the current Grant, and the average packet delay will be shorter.

The *Linear Credit* scheme uses a similar approach as the Constant Credit scheme. However, the size of the credit is proportional to the requested window. The reasoning here is the following: network traffic possesses a certain degree of predictability [7] specifically; if we observe a long burst of data, this burst is likely to continue for some time into the future. Correspondingly, the arrival of more data during the last cycle may signal that we are observing a burst of packets.

Elastic service is an attempt to get rid of a fixed maximum window limit. The only limiting factor is the maximum cycle time T_{MAX}. The maximum window is granted in such a way that the accumulated size of last N Grants (including the one being granted) does not exceed $N \times W_{MAX}$ bytes (where N is the number of ONUs). Thus, if only one ONU has data to send, it may get a Grant of size up to $N \times W_{MAX}$.

It is worth mentioning that because each polling table entry should be updated before issuing a Grant to the corresponding ONU, the cycle time can never be less than maximum RTT to any of the ONUs in the PON. If an ONU is ready to be polled but the previous Request has not arrived yet, the algorithm will have to pause. To remedy such inefficiency, the algorithm may grant larger than requested transmission slots to ensure that sum of all granted slots and corresponding guard times is at least as large as the maximum RTT. We have not considered the effects of such optimization in this study.



■ **Figure 4.** *Average queue size.*

Model Description

In this study we consider a PON access network consisting of an OLT and N ONUs (Fig. 1). Every ONU is assigned a downstream propagation delay (from the OLT to the ONU) and an upstream propagation delay (from the ONU to the OLT). To keep the model general, we assume independent upstream and downstream propagation delays and select them randomly (uniformly) over the interval [50 μs, 100 μs]. These values correspond to distances between the OLT and ONUs ranging from 10 to 20 km.

The transmission speeds of the PON and user access link may not necessarily be the same. In our model we consider R_D Mb/s to be the data rate of the access link from a user to an ONU, and R_U Mb/s to be the rate of the upstream link from an ONU to the OLT (Fig. 1). We should mention here that if $R_U \geq N \times R_D$, the bandwidth utilization problem does not exist, since the system throughput is higher than the peak aggregated load from all ONUs. In this study we consider a system with $N = 16$ and R_D and R_U being 100 Mb/s and 1000 Mb/s, respectively. Every ONU has a finite memory buffer of size Q. In our simulations, Q was set to 10 Mbytes.

To obtain an accurate and realistic performance analysis, it is very important to simulate the system behavior with appropriate traffic injected into the system. Our simulation was performed using synthetic traffic traces that exhibit the properties of self-similarity and long-range dependence (LRD).

To generate self-similar traffic, we used the method described in [8], where the resulting traffic is an aggregation of multiple streams, each consisting of alternating Pareto-distributed ON/OFF periods. In our implementation every stream generates Ethernet packets that are transmitted in packet trains (bursts). The number of packets per burst (ON period) follows the Pareto distribution with a minimum of 1 (i.e., the smallest burst consist of only 1 packet) and shape parameter $\alpha = 1.4$. The choice of α was prompted by measurements on actual Ethernet traffic performed by Leland *et al.* [9]. They reported the measured Hurst parameter of approximately 0.8 for moderate network load.

The relationship between the Hurst parameter H and the shape parameter α is $H = (3 - \alpha)/s$ [8]. We have verified that the Hurst parameter of the resulting data stream indeed equals 0.8.

Simulation Results

In Fig. 3 we present the mean packet delay for different Grant scheduling services as a function of an ONU's offered load. In this simulation all ONUs had identical load.

As can be seen in the figure, all granting services except fixed service have almost coinciding plots. We will discuss fixed service results below. As for the rest of them, no other method gives a detectable improvement in packet delay. The explanation of this lies in the fact that all these methods are trying to send more data by way of increasing the granted window size. While that may clear the queue in fewer polling cycles, the polling cycle itself will increase. Overall, all these services have negligible effect on packet delay.

The fixed service plot is interesting as an illustration of the traffic long-range dependence. Even at the very light load of 5 percent, the average packet delay is already very high (~15 ms). This is because most packets arrive in very large packet trains. In fact, the packet trains were so large that the 10-Mbyte buffers overflowed and about 0.14 percent of packets were dropped. Why do we observe this anomalous behavior only with fixed service? The reason is that all other services have much shorter cycle times; there is just not enough time in a cycle to receive more bytes than W_{MAX}; thus, the queue never builds up. In fixed service, on the other hand, the cycle is large (and fixed) from the very beginning, and several bursts that arrive close to each other can easily overflow the buffer.

We want to note here that the reduced cycle time that adapts exactly to the amount of data available in the ONUs is the main advantage of the proposed algorithm.

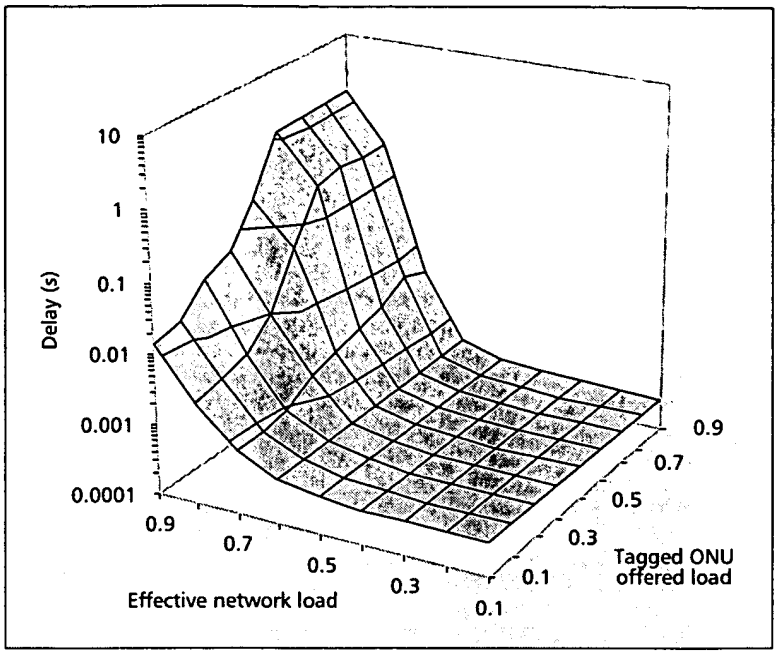
Figure 4 presents the simulation results for the average queue size and is similar to the mean delay plot. Again, fixed service has a larger queue, which comes as no surprise. That leads to a conclusion that neither of the discussed service disciplines is better than limited service. As such, for the remainder of this study we will focus our attention on the limited service discipline.

Performance of Limited Service

In this section we analyze the performance of a tagged ONU i as a function of its offered load and the effective load of the entire network. In Fig. 5, we present the average packet delay.

When the effective network load is low, all packets in a tagged source experience very little delay, no matter what the ONU's offered load is. This is a manifestation of dynamic bandwidth allocation — when the network load is low, the tagged source gets more bandwidth.

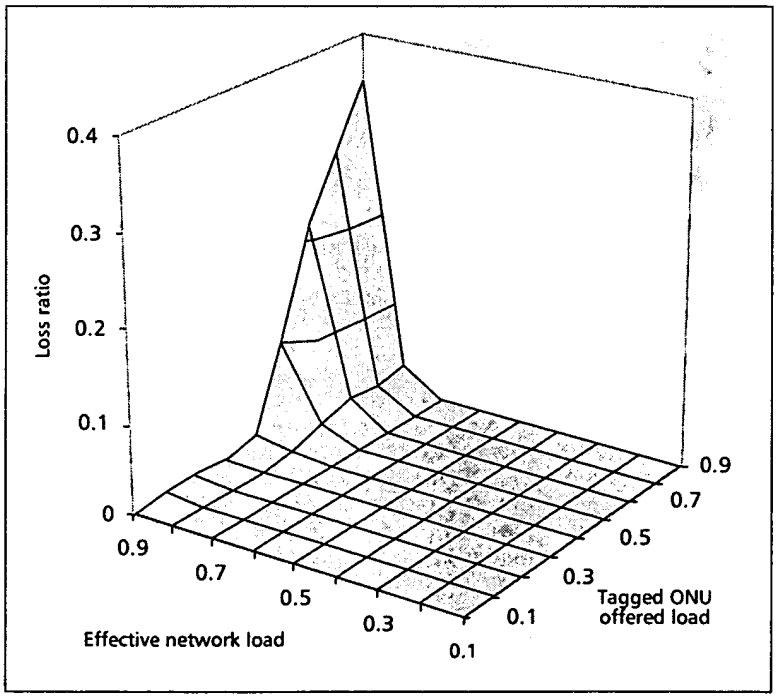
The opposite situation — low offered load at the ONU and high effective network load — results in higher delay. The only reason for this is the burstiness (i.e., long-range dependence) of the traffic. This is the same phenomenon observed with fixed service; the only difference is that in fixed service the cycle time is large and fixed independent of the effective load. In the current case, the cycle time is large because of increased effective network load. This cycle time is large enough to receive more than W_{MAX} bytes of data during a burst. Hence, the queuing delay for some packets will increase beyond one cycle time.



■ **Figure 5.** *Average packet delay as a function of effective network load and ONU offered load.*

Figure 6 shows the probability of a packet loss in a tagged ONU i as a function of its offered load and the effective load of the entire network.

Once again we observe that packet loss is



■ **Figure 6.** *Packet loss probability as a function of effective network load and ONU offered load.*

We believe that a PON based on polling and with data encapsulated in Ethernet frames possesses very desirable qualities, such as use of a single downstream and a single upstream wavelength, ability to provision a fractional wavelength capacity to each user, and so on.

zero or negligible if the effective network load is less than 80 percent. When the network load is above 80 percent and the tagged ONU offered load is above 50 percent (50 Mb/s), we observe considerable packet loss due to buffer overflow, even though the guaranteed bandwidth available to tagged ONU is 60 Mb/s. This is again the consequence of traffic burstiness.

Conclusion

In this study we discuss and evaluate design issues that must be dealt with in a PON access network. Specifically, to drive the cost of an access network down, it is very important to have an efficient scalable solution. We believe that a PON based on polling and with data encapsulated in Ethernet frames possesses very desirable qualities, such as use of a single downstream and a single upstream wavelength, and the ability to provision a fractional wavelength capacity to each user.

We present a simple algorithm for dynamic bandwidth allocation based on an interleaved polling scheme with an adaptive cycle time. We suggest a novel approach for an in-band signaling that allows use of a single wavelength for both downstream data and Grant transmission. Also, we showed this approach to be scalable with the number of ONUs in the system.

Since each ONU uses the window size required at the moment, the polling cycle time *adapts* to the instantaneous queue loads, leading to an adaptive cycle time. This is the basic idea behind the fair unused bandwidth redistribution: reduced cycle time leads to an increase in the amount of best-effort bandwidth available to busy ONUs. This increase is proportional to their bandwidth needs.

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EPON UpstreamMultipleAccess Scheme

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Abstract

This paper presents the concepts and features of Ethernet Passive Optical Network (EPON). As well as discussion of upstream multiple access schemes in depth, a new proposal and analytical model of it are developed. With a simple example of fixed Maximum Transmission Window (MTW) allocation, this paper demonstrates some simulation considerations. Finally, this paper gives the statistic results to support our analysis and models.

Keywords: EPON, Upstream Multiple Access Scheme, TDMA, Grant, Request, MTW, MTW Allocation Algorithm

I. Introduction

EPON is one of the newest technologies for the transmission of IEEE802.3 format frame [1] in access network. Since its downstream channel uses true broadcast while the upstream channel uses multi-access, the most challenging and interesting issue of EPON is the upstream multiple access scheme.

This paper introduces an EPON upstream multiple access scheme, then gives an analytical model providing a quantitative performance evaluation for it. Architecture [3,4] and features of EPON are described briefly in section II. Upstream multiple access schemes are discussed amply in section III, including the Request/Grant mechanism and an example MTW allocation algorithm. As a simple scheme, it is useful as a possible start pointer for future work. Next, the simulation model is presented in section IV. Finally, in section V, analysis based on simulation results is given, as well as some conclusions.

II. EPON Network Architecture

The optical section of EPON is a passive point-to-multipoint architecture. The architecture ranges from FTTH (Fiber to the Home), through FTTB/C (Fiber to the Building/Curb) to FTTCab (Fiber to the Cabinet). The FTTB/C and FTTCab network options are different in implementation but similar in analysis.

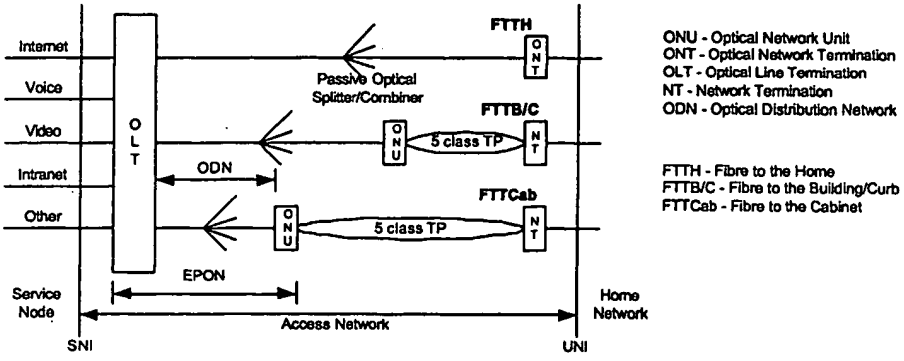


Figure.1 EPON Network Architecture

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As shown in figure.1, this system consists of optical line termination (OLT), optical network unit (ONU) and fiber cable which has a passive optical network (PON) configuration with a passive optical splitter. One fiber is passively split between multiple ONU' S who share the capacity of it.

In EPON architecture, downstream direction is defined as frames traveling direction from the OLT to the ONU(s), and upstream direction is from the ONU(s) to the OLT.

Optical Line Termination

The Optical Line Termination (OLT) interfaces over the Service Node Interface (SNI) to service nodes, and to the ODN. OLT manages all the PON specific aspects of the transport system. ONU and OLT provide transparent IEEE802.3 frame transport service between the UNIs and the SNI over the PON.

The OLT is the core of EPON. It broadcasts IEEE802.3 frames from service nodes to all ONUs in the downstream channel and tailors frames from every ONU in upstream channel. Also, OLT controls ONUs' accessing upstream channel at proper time so that they can send frames in upstream without collision. As the interface between the service nodes and PON, OLT can switch the requirements from ONU to proper service nodes and forward acknowledges to ONU.

Optical Network UnfOptical Network Termination

The optical network unit (ONU) or optical network termination (ONT) interfaces over the ODN to the OLT, and to the UNI. Under the control of OLT, the ONU provide transparent 802.3 frame transport between the UNI and the SNI. In downstream direction, ONU receives broadcast frames from OLT and filter them by the destination address. To access upstream channel, ONU must wait for the grant distributed by OLT. In addition, ONU send the requests to OLT to report the transmission window it required.

Optical Distribution Network

The Optical Distribution Network (ODN) provides the optical transmission means from the OLT towards the users and vice versa. It utilizes passive optical components.

III. Upstream Multiple Access Scheme

The objective of upstream multiple access schemes are to guarantee the fair and efficient utilization of upstream channel.

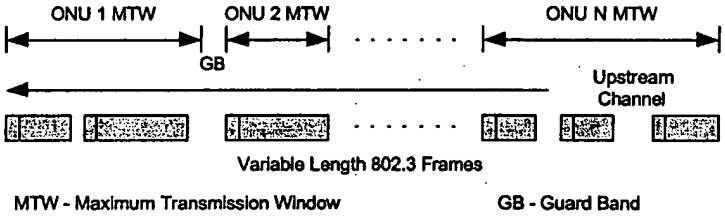


Figure.2 Upstream Channel

Figure 2 shows a typical state of upstream channel after implementing the upstream multiple access schemes. ONUs send 802.3 frames in the transmission window assigned by OLT without changing them. From OLT's point, upstream channel consists a sequence of 802.3 frames with variable intervals. We define some parameters to characterize the upstream channel, including:

1. ONU Number (N), indicating the total number of ONU in the system;
2. Maximum Transmission Window (MTW, in bytes), used to limit the transmission window of ONU;
3. Guard Band (GB, in bytes), representing the unassigned band between two transmission windows for preventing the collision;

4. Upstream Link Data Rate (R_{up} in bps), illustrating the maximum link speed of upstream channel.

Obviously, the distribution of MTW is the key issue of the upstream link utilization. Our proposal is to use the Request/Grant mechanism to realize the dynamic allocation of MTW.

Request/Grant Mechanism

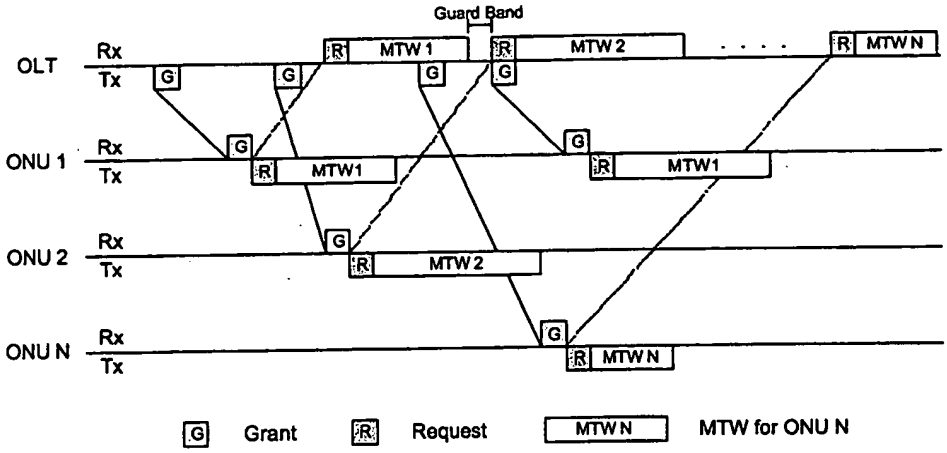


Figure.3 Request/Grant Mhanism

The Grant is control message to inform an ONU the beginning of its transmission window and the size of it. When receiving the grant for itself, ONU begin sending data upstream, including a Request message that conveys the transmission window requirement to OLT. Based on this request and the MTW allocation algorithm, OLT generates the next grant for this ONU. The Request/Grant mechanism is an interactive process, and combining with different MTW allocation algorithm, it can achieve very flexible and efficient usage of upstream channel. Propagation delay should be considered carefully in implementation, but the compensation of the propagation delay difference of ONUs is beyond the scope of this paper.

Example MTW Allocation Algorithm

As a start point, we introduce a simple scheme, fixed MTW scheme. In this case, OLT allocate equal MTW to every ONU without taking caring of request of ONU. What OLT need to do is to send Grant to each ONU at particular time. When receiving the Grand, ONU just send IEEE802.3 frames waiting in the queue, with a total length less than or equal to the MTW.

This scheme guarantees the bandwidth of each ONU, which is given by Eq(1). The bandwidth of each ONU is determined by the MTW assign for it and the sum of total MTW and the Guard Band.

$$B_{ONU} = \frac{MTW_i}{\sum_{i=1}^{N}(MTW_i + GB)} \times R_{up} \qquad Eq(1)$$

$$Tc = \frac{\sum_{i=1}^{N}(MTW_i + GB)}{R_{up}} \qquad Eq(2)$$

Since every frame in the queue of ONU cannot be sent until receiving enough upstream transmission window, EPON actually introduces additional delay for these frames besides the propagation delay caused by the fiber. Before investigating this effect, we give the total transmission cycle (Tc in S) of all ONU by Eq(2).

For a frame arrives at ONU, it has to wait at least two transmission windows before being send. In the first window, a Request for this frame can be sent to OLT. Then it can be sent in the second windows. That means even in the best case, additional delay is larger than Tc. And maybe, in the worst case, it is larger than two times of Tc. In our fixed MTW scheme, the delay may reduce to a value less than the Tc since there is no need for Request.

In conclusion, with determined R_{up}, the MTW has the significant effects on both the bandwidth assignments and

additional delay of the scheme. To improve the efficiency of upstream access scheme, we need to optimize the MTW allocation algorithm. For instance, it may take into account ONU' s transmission window requirement, the priority of the ONU and even the class of service when calculating the MTWs.

IV. Modeling and Simulation for MTW Allocation Algorithm

In order to illustrate the behavior of MTW Allocation Algorithm, we built models for all of the components in EPON. Since the purpose of these models is simulation, and especially performance estimation, subordinate factors have been simplified or omitted.

Frame Formats

We defined three types of frame, which should be supported by all models in the system. They are as follows:

- IEEE802.3 frame styles specified in IEEE802.3 standard.
- Grant frame, which carries the destination ONU address and MTW.
- Request frame, which contains the ONU address and required transmission window.

OLT Model

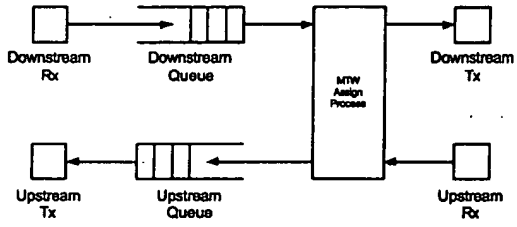


Figure.4 OLT Model

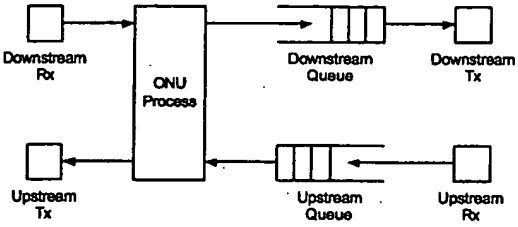


Figure.5 ONU Model

As shown in figure.4, OLT model consists of two queues, which are used to store downstream and upstream frames, one processor, which is used to implement MTW Allocation Algorithm, and several transceivers.

Once Downstream Rx module received an IEEE802.3 frame, it will be inserted into the tail of Downstream Queue. Under the control of the processor, the IEEE802.3 frame in the head of queue can be forwarded to the Downstream Tx module and transmit to downstream channel.

At the same time, Upstream Rx module delivers the upstream frames to the processor, and the frames will be inserted into the tail of Upstream Queue except the Request frames. Upstream Tx module will transmit the frame from the head of Upstream Queue to service nodes.

When Upstream Rx module received the Request frames, the processor will get the required transmission window information. Based on this information as well as other facts, the processor will calculate the MTW for ONU and generate a Grant frame containing new MTW. Then this Grant frame will be sent to the Downstream Tx module and transmit it downstream at specified time.

In this model, the processor just distributes fixed MTW without considering the request of ONU or other issues. New MTW Allocation algorithm could be implemented and studied when replacing it with another processor.

ONU Model

Figure.5 illustrates the ONU model. Like OLT, ONU also consists of one processor, two queues, and several transceivers.

Once Upstream Rx module received an IEEE802.3 frame from user, it will be inserted into the tail of Upstream Queue. Then the processor will decide when to fetch the first frame in the queue and how many bits to be transmitted upstream according to the Grant frame. In addition, processor should have the ability to generate Request frame, which could convey the information needed by OLT when assigned MTW.

In downstream direction, the processor filters the incoming Grant frame from the downstream frames. For ordinary IEEE802.3 frame, it was just add to the tail of Downstream Queue. On the other hand, for the Grant frames, the processor must decide whether the destination of them is itself by comparing the ONU address in the frame with ONU' s own address, and then discard those for other ONUs.

ONU model can be used for the research of other algorithms without any modification.

Optical Splitter and Combiner Model

Optical splitter and combiner is a part of ODN in practical EPON. Its model must support its functions logically by forwarding frames coming from OLT to all ONU and combining all upstream data into one channel.

Link Model

Since the downstream and upstream channel of EPON may operate at different rate. Our link model is a point-to-point single direction link with configurable bit rate and no propagation delay. Two links can represent a full duplex data link between two nodes of EPON.

Application Model

EPON is a kind of extension of Ethernet. So the popular applications that use Ethernet as underlying data delivery network will also appear on EPON. WWW browsers, File Transfer, E-mail, database transactions and so on are all typical traffics. Each of them causes and experiences a different set of problems in the underlying network, so it is desirable to accurately simulate the traffic patterns generated by a variety of applications. Fortunately, we found a simulation tool including all of them and more, such as video conferencing and voice communication. [5]

As another choice, we construct a more general data source model, which supports generating traffic with different frame structure, length, inter arrival time and bit rate. And all variables can be set to conform to particular probability distribution.

Simulation Configuration

Since the bandwidth for each ONU is a predetermined value in our scheme, our simulation focuses on the delay performance of fixed MTW scheme in different MTW configuration. For an instance, we only consider the ONU queuing delay (the total time for a frame waiting in ONU queue) in 8-ONUs configuration.

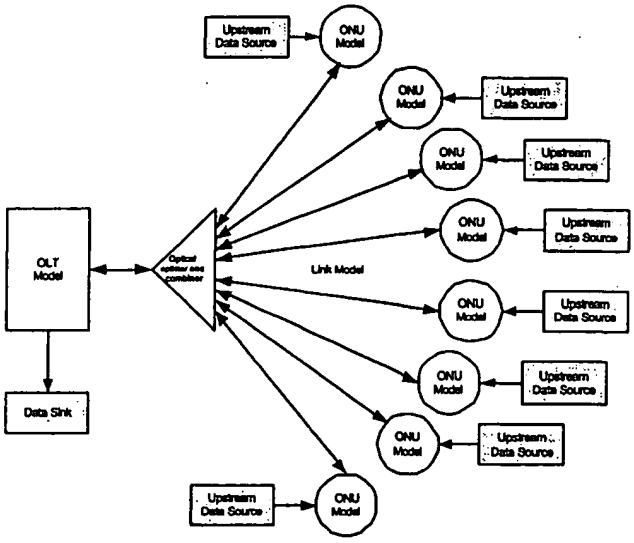


Figure.6 8 ONU Simulation Configuration

During simulation, we set upstream and downstream data rates as 100Mbps and a Guard Band of 8 bytes. And each upstream data source generates one type of upstream traffic with a data rate of 12.5 Mbps derived from the Eq (1). Then, we also change the MTWs from 1518bytes (maximum length of 802.3 frame) to ten times of it during simulation, as listed in table below.

Sim Time	ONU sum	MTW	Data Source Traffic Feature	Statistics
0.05 S	8	1518	Variable length from 64 bytes to 1518 bytes conform to uniform distribution	ONU Queuing Delay
0.05 S		15180	Variable inter arrival time from 0.96us to 4*0.96us conform to uniform distribution	

V. Simulation Result Analysis

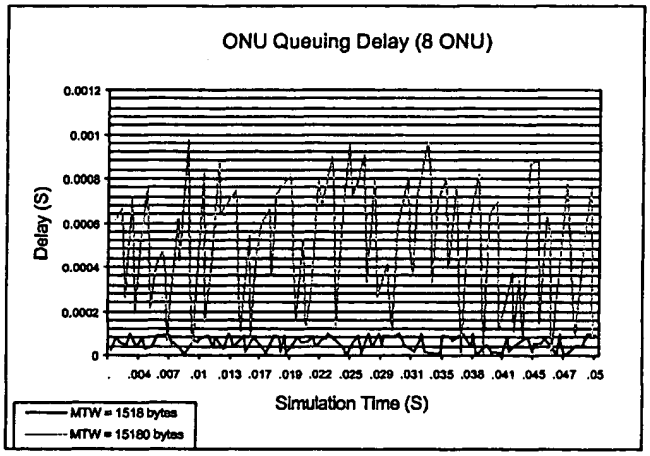


Figure.7 Simulation Result

Figure.7 shows ONU queuing delays in different MTW configurations. The maximum ONU Queuing Delay is approximate to ten times larger when MTW increases from 1518 bytes to 15180 bytes. And in both cases, the maximum delays are less than T_c given by Eq (2), which is properly matched with our analysis in section III.

VI. Conclusions

Upstream Multiple Access Scheme is one of the most essential points in EPON technology. By putting forward a simple proposal, this paper illustrates the importance of MTW allocation algorithm and builds an analytical model for it. And the model is proven to be correct by the statistics results of simulation.

VII. Reference

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Ethernet Passive Optical Network (EPON): Building a Next-Generation Optical Access Network

Glen Kramer and Gerry Pesavento, Alloptic, Inc.

ABSTRACT

This article describes Ethernet passive optical networks, an emerging local subscriber access architecture that combines low-cost point-to-multipoint fiber infrastructure with Ethernet. EPONs are designed to carry Ethernet frames at standard Ethernet rates. An EPON uses a single trunk fiber that extends from a central office to a passive optical splitter, which then fans out to multiple optical drop fibers connected to subscriber nodes. Other than the end terminating equipment, no component in the network requires electrical power, hence the term passive. Local carriers have long been interested in passive optical networks for the benefits they offer: minimal fiber infrastructure and no powering requirement in the outside plant. With Ethernet now emerging as the protocol of choice for carrying IP traffic in metro and access networks, EPON has emerged as a potential optimized architecture for fiber to the building and fiber to the home.

INTRODUCTION

While in recent years the telecommunications backbone has experienced substantial growth, little has changed in the access network. The tremendous growth of Internet traffic has accentuated the aggravating lag of access network capacity. The "last mile" still remains the bottleneck between high-capacity local area networks (LANs) and the backbone network. The most widely deployed broadband solutions today are digital subscriber line (DSL) and cable modem (CM) networks. Although they are an improvement over 56 kb/s modems, they are unable to provide enough bandwidth for emerging services such as IP telephony, video on demand (VoD), interactive gaming, or two-way videoconferencing. A new technology is required; one that is inexpensive, simple, scalable, and capable of delivering bundled voice, data, and video services to an end-user subscriber over a single network. Ethernet passive optical networks (EPONs), which represent the convergence of low-cost Ethernet equipment and low-cost fiber infrastructure, appear to be the best candidate for the next-generation access network.

EVOLUTION OF THE FIRST MILE

The first mile? Once called the last mile, the Ethernet community has renamed this network section to the first mile, to symbolize its priority and importance. The first mile connects the service provider central offices to business and residential subscribers. Also referred to as the subscriber access network or local loop, it is network infrastructure at the neighborhood level. Residential subscribers demand first mile access solutions that are broadband, offer Internet media-rich services, and are comparable in price to existing networks.

Incumbent telephone companies responded to Internet access demand by deploying DSL technology. DSL uses the same twisted pair as telephony lines and requires a DSL modem at the customer premises and a digital subscriber line access multiplexor (DSLAM) in the central office. The data rate provided by DSL is typically offered in a range of 128 kb/s–1.5 Mb/s. While this is significantly faster than an analog modem, it is well shy of being considered broadband, in that it cannot support full-service voice, data, and video. In addition, the physical area one central office can cover with DSL is limited to distances less than 5.5 km, which constitutes approximately 60 percent of end-user subscribers. As a result, network operators are now deploying remote DSLAMS closer to subscribers; however, in general, service providers do not provide DSL services to subscribers located more than a few miles from a local exchange office due to costs [1].

Cable television companies responded to Internet service demand by integrating data services over their coaxial cable networks, which were originally designed for analog video broadcast. Typically, these hybrid fiber coax (HFC) networks have fiber running between a video

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head-end or hub to a curbside optical node, with the final drop to the subscriber being coaxial cable, repeaters, and tap couplers. The drawback of this architecture is that each shared optical node has less than 36 Mb/s effective data throughput, which is typically divided between 2000 homes, resulting in frustrating slow speed during peak hours. To alleviate bandwidth bottlenecks, optical fibers, and thus optical nodes, are penetrating deeper into the first mile.

The next wave of local access deployment promises to bring fiber to the building (FTTB) and fiber to the home (FTTH). Unlike previous architectures, where fiber is used as a feeder to shorten the lengths of copper and coaxial networks, these new deployments use optical fiber throughout the access network. New optical fiber network architectures are emerging that are capable of supporting gigabit per second speeds, at costs comparable to DSL and HFC networks.

Traffic Growth

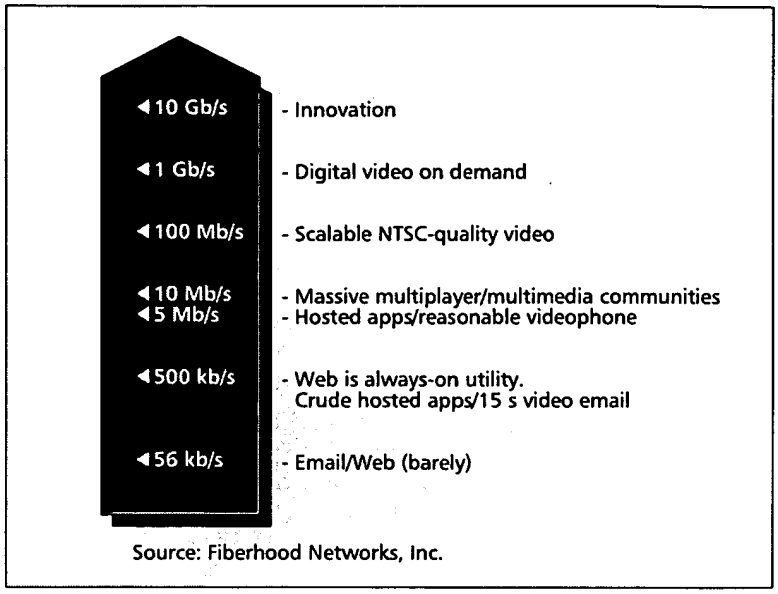
Data traffic is increasing at an unprecedented rate. Sustainable data traffic growth rate of over 100 percent per year is observed since 1990. There were periods when a combination of economical and technological factors resulted in even larger growth rates (1000 percent increase per year in 1995 and 1996) [2]. This trend is likely to continue in the future. Simply put, more and more users are getting online, and those who are already online are spending more time online. Market research shows that after upgrading to a broadband connection users spend about 35 percent more time online than before [3]. Voice traffic is also growing, but at a much slower rate of 8 percent annually. According to most analysts, data traffic has already surpassed voice traffic. More and more subscribers telecommute, and require the same network performance as they see on corporate LANs. More services and new applications will become available as bandwidth per user increases (Fig. 1).

Neither DSL nor CMs can keep up with such demand. Both technologies are built on top of existing copper communication infrastructure not optimized for data traffic. In CM networks, only a few RF channels are dedicated to data, while the majority of bandwidth is tied up servicing legacy analog video. DSL copper networks do not allow sufficient data rates at required distances. Most network operators have come to the realization that a new data-centric solution is necessary. Such a technology would be optimized for Internet Protocol (IP) data traffic. The remaining services, such as voice and video, will converge into a digital format, and a true full-service network will emerge.

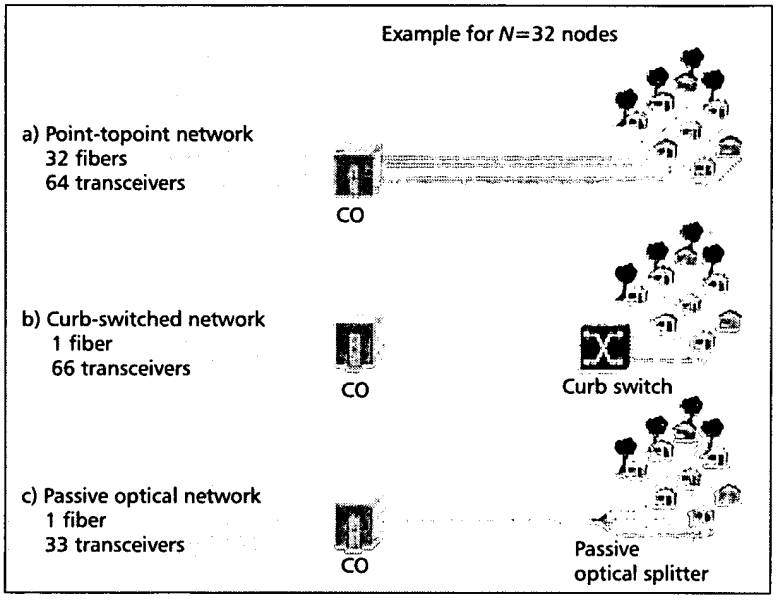
The Next-Generation Access Network

Optical fiber is capable of delivering bandwidth-intensive integrated, voice, data, and video services at distances beyond 20 km in the subscriber access network. A logical way to deploy optical fiber in the local access network is using a point-to-point (P2P) topology, with dedicated fiber runs from the local exchange to each end-user subscriber (Fig. 2a). While this is a simple architecture, in most cases it is cost prohibitive due to the fact that it requires significant outside plant fiber deployment as well as connector termination space in the local exchange. Considering N subscribers at an average distance L km from the central office, a P2P design requires $2N$ transceivers and $N * L$ total fiber length (assuming single fiber is used for bidirectional transmission).

To reduce fiber deployment, it is possible to deploy a remote switch (concentrator) close to the neighborhood. This reduces fiber consumption to only L km (assuming negligible distance between the switch and customers), but actually increases the number of transceivers to $2N + 2$, since there is one more link added to the network (Fig. 2b). In addition, a curb-switched architecture requires electrical power as well as backup power at the curb unit. Currently, one of the highest costs for local exchange carriers is providing and maintaining electrical power in the local loop.

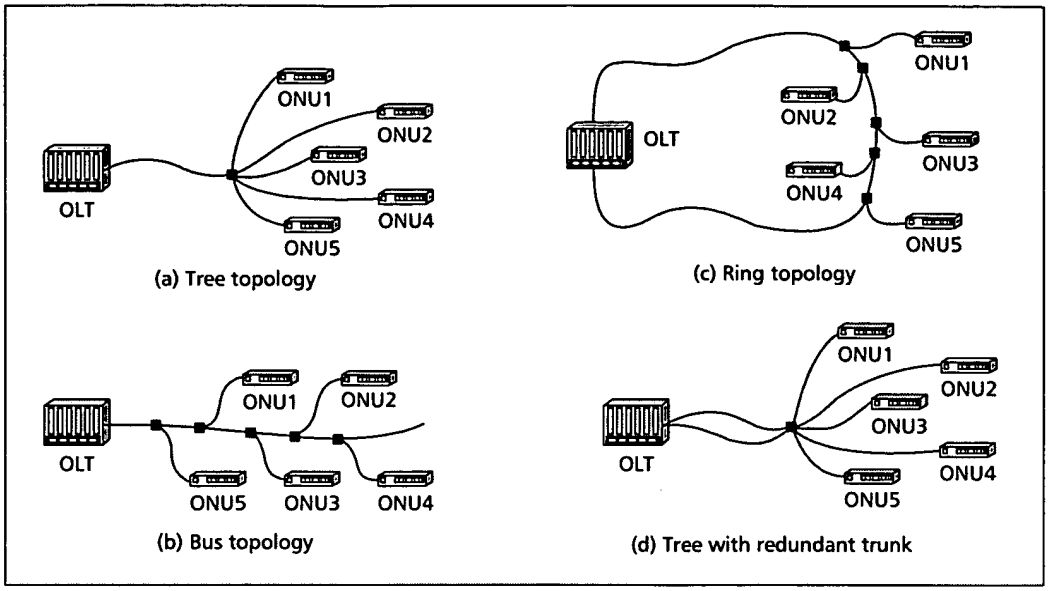


■ **Figure 1.** *Per-user bandwidth requirements for new services.*



■ **Figure 2.** *Fiber to the home (FTTH) deployment scenarios.*

Logically, the first mile is point-to-multipoint, with a Central Office typically servicing thousands of subscribers. There are several multipoint topologies suitable for the access network, including tree, tree-and-branch, ring, or bus.



■ **Figure 3.** *PON topologies.*

Therefore, it is logical to replace the hardened active curb-side switch with an inexpensive passive optical component. Passive optical network (PON) is a technology viewed by many as an attractive solution to the first mile problem [4, 5]; PONs minimize the amount of optical transceivers, central office terminations, and fiber deployment. A PON is a point-to-multipoint optical network with no active elements in the signals' path from source to destination. The only interior elements used in a PON are passive optical components, such as optical fiber, splices, and splitters. Access networks based on single-fiber PON only require $N + 1$ transceivers and L km of fiber (Fig. 2c).

PON Topologies

Logically, the first mile is point-to-multipoint (P2MP), with a central office typically servicing thousands of subscribers. There are several multipoint topologies suitable for the access network, including tree, tree-and-branch, ring, and bus (Fig. 3). Using 1:2 optical tap couplers and 1:N optical splitters, PONs can be flexibly deployed in any of these topologies. In addition, PONs can be deployed in redundant configurations such as double rings or double trees; or redundancy may be added only to a part of the PON, say the trunk of the tree (Fig. 3d).

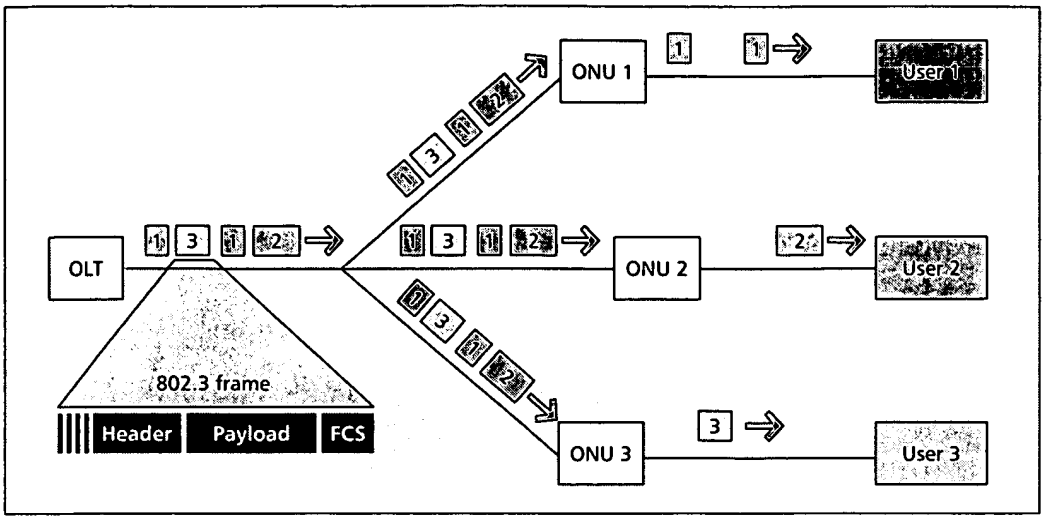
All transmissions in a PON are performed between an optical line terminal (OLT) and optical network units (ONUs). The OLT resides in the local exchange (central office), connecting the optical access network to the metro backbone. The ONU is located at either the curb (FTTC solution) or the end-user location (FTTH and FTTB), and provides broadband voice, data, and video services. In the downstream direction (from OLT to ONUs), a PON is a P2MP network, and in the upstream direction it is a multipoint-to-point network.

The advantages of using PONs in subscriber access networks are numerous:

- PONs allow for long reach between central offices and customer premises, operating at distances over 20 km.
- PONs minimizes fiber deployment in both the local exchange office and the local loop.
- PONs provides higher bandwidth due to deeper fiber penetration, offering gigabit per second solutions.
- Operating in the downstream as a broadcast network, PONs allow for video broadcasting as either IP video or analog video using a separate wavelength overlay.
- PONs eliminate the necessity to install active multiplexers at splitting locations, thus relieving network operators of the gruesome task of maintaining active curb-side units and providing power to them. Instead of active devices in these locations, PONs use small passive optical splitters, located in splice trays and deployed as part of the optical fiber cable plant.
- Being optically transparent end to end, PONs allow upgrades to higher bit rates or additional wavelengths.

APON to EPON

Passive optical networking has been considered for the access network for quite some time, even well before the Internet spurred bandwidth demand. The Full Service Access Network (FSAN) Recommendation (ITU G.983) defines a PON-based optical access network that uses asynchronous transfer mode (ATM) as its layer 2 protocol. In 1995, when the FSAN initiative started, ATM had high hopes of becoming the prevalent technology in the LAN, MAN, and backbone. However, since that time, Ethernet technology has leapfrogged ATM. Ethernet has become a universally accepted standard, with over 320 million port deployments worldwide, offering staggering economies of scale [6]. High-speed Gigabit Ethernet deployment is widely accelerating and 10 Gigabit Ethernet products are available. Ethernet, which is easy to scale and manage, is win-



■ **Figure 4.** *Downstream traffic in EPON.*

Newly adopted Quality of Service (QoS) techniques have made Ethernet networks capable of supporting voice, data and video. Ethernet is an inexpensive technology, that is ubiquitous and interoperable with a variety of legacy equipment.

ning new ground in MANs and WANs. Considering that 95 percent of LANs use Ethernet, ATM PON may not be the best choice to interconnect two Ethernet networks.

One of ATM's shortcomings is the fact that a dropped or corrupted cell will invalidate the entire IP datagram. However, the remaining cells carrying the portions of the same IP datagram will propagate further, thus consuming network resources unnecessarily. Also, ATM imposes a cell tax on variable-length IP packets. For example, for the trimodal packet size distribution reported in [7], the cell tax is approximately 13 percent; that is, to send the same amount of user's data an ATM network must transmit 13 percent more bytes than an Ethernet network (counting 64-bit preamble and 96-bit IPG in Ethernet and 12 bytes of overhead associated with AAL-5 in ATM). Finally, perhaps most important, ATM did not live up to its promise of becoming an inexpensive technology; vendors are in decline and manufacturing volumes relatively low. ATM switches and network cards are significantly (roughly 8 ×) more expensive than Ethernet switches and network cards [6].

On the other hand, Ethernet looks like a logical choice for an IP data-optimized access network. An Ethernet PON (EPON) is a PON that carries all data encapsulated in Ethernet frames. Newly adopted quality of service (QoS) techniques have made Ethernet networks capable of supporting voice, data, and video. These techniques include full-duplex support, prioritization (p802.1p), and virtual LAN (VLAN) tagging (P802.1Q). Ethernet is an inexpensive technology that is ubiquitous and interoperable with a variety of legacy equipment.

An EPON Network

The IEEE 802.3 standard defines two basic configurations for an Ethernet network. In one case it can be deployed over a shared medium using carrier sense multiple access with collision detection (CSMA/CD) protocol. In another case stations may be connected through a switch using full-duplex links. Properties of an EPON are such that it cannot be considered either shared medium or a point-to-point network; rather, it is a combination of both.

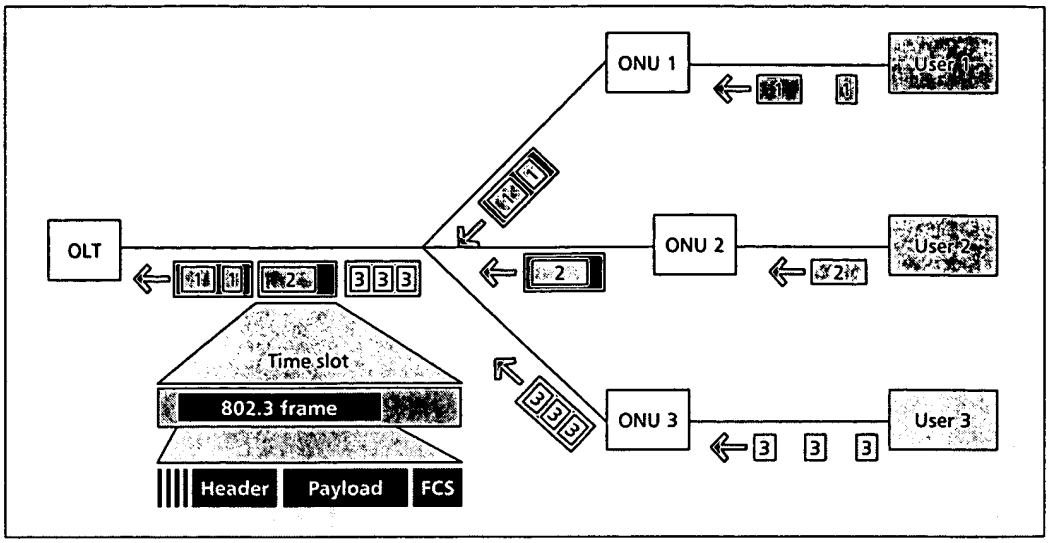
In the downstream direction, Ethernet frames transmitted by OLT pass through a 1:*N* passive splitter and reach each ONU. Splitting ratios are typically between 4 and 64. This behavior is similar to a shared media network. Because Ethernet is broadcasting by nature, in the downstream direction (from network to user), it fits perfectly with the EPON architecture: packets are broadcast by the OLT and extracted by their destination ONU based on the media access control (MAC) address (Fig. 4).

In the upstream direction, due to directional properties of a passive combiner (optical splitter), data frames from any ONU will only reach the OLT, not other ONUs. In that sense, in the upstream the behavior of EPON is similar to that of a P2P architecture. However, unlike in a true P2P network, in EPON frames from different ONUs transmitted simultaneously still may collide. Thus, in the upstream direction (from user to network), the ONUs need to share the trunk fiber channel capacity and resources.

Multiple Access

One possible way of separating the channels is to use wavelength division multiplexing (WDM), in which each ONU operates at a different wavelength. While a simple (from a theoretical perspective) solution, it remains cost prohibitive for an access network. A WDM solution would require either a tunable receiver or a receiver array at the OLT to receive multiple channels. An even more serious problem for network operators would be wavelength-specific ONU inventory: instead of having just one type of ONU, there would be multiple types of ONUs based on their laser wavelength. It would also be more problematic for an unqualified user to replace a defective ONU. Using tunable lasers in ONUs is too expensive at the current state of technology. For these reasons a WDM PON network is not an attractive solution in today's environment.

We believe time-sharing is the preferred method of optical channel sharing in an access network as it allows for a single upstream wavelength, such as 1310 nm, and a single transceiver in the OLT, resulting in a cost-effective solution.



■ **Figure 5.** *Upstream traffic in EPON.*

Contention-based media access (something similar to CSMA/CD) is difficult to implement because ONUs cannot detect a collision at the OLT (because of directional properties of optical splitter/combiner). An OLT could detect a collision and inform ONUs by sending a jam signal, however, propagation delays in PON, which can exceed 20 km in length, greatly reduce the efficiency of such a scheme. Contention-based schemes also have a drawback of providing a nondeterministic service; that is, node throughput and channel utilization may be described as statistical averages. On a small scale (comparable to propagation delay) there is no guarantee of a node getting access to the media. It is not a problem for CSMA/CD-based enterprise networks where links are short and typically overprovisioned, and traffic predominantly consists of data. Subscriber access networks, however, in addition to data, must support voice and video services, and thus must provide some guarantees on timely delivery of these traffic types.

We believe time-sharing is the preferred method of optical channel sharing in an access network because it allows for a single upstream wavelength (e.g., 1310 nm) and a single transceiver in the OLT, resulting in a cost-effective solution.

To introduce determinism in the frame delivery, different noncontention schemes were proposed. Figure 5 illustrates an upstream time-shared data flow in EPON.

All ONUs are synchronized to a common time reference, and each ONU is allocated a time slot. Each time slot is capable of carrying several Ethernet frames. An ONU should buffer frames received from a subscriber until its time slot arrives. When its time slot arrives, the ONU would "burst" all stored frames at full channel speed (standard Ethernet rate). If there are no frames in the buffer to fill the entire time slot, idles are transmitted. The possible time slot allocation schemes could range from a static allocation (fixed time-division multiple access, TDMA) to a dynamically adapting scheme based on instantaneous queue size in every ONU (statistical multiplexing scheme). There are more allocation schemes possible, including schemes utilizing traffic priority and QoS, service level agreements (SLAs), and oversubscription ratios.

Decentralized approaches to implementing a dynamic slot assignment scheme are also possible, in which ONUs decide when to send data and for how long. These schemes are somewhat similar to a token ring, except that in this case it is a passive ring. In such a scheme, every ONU, before sending its data, will send a special message announcing how many bytes it is about to send. The ONU scheduled next (say, in round-robin fashion) will monitor the transmission of the previous ONU and time its transmission so that it arrives to the OLT right after transmission from the previous ONU. Thus, there will be no collision, and no bandwidth will be wasted. This scheme is similar to hub polling [8]. However, this scheme has a major limitation: it requires connectivity (communicability) between ONUs. This imposes some constraints on PON topology; namely, the network should be deployed as a ring or a broadcasting star. This requirement is not desirable since:

- It may require more fiber to be deployed.
- Fiber plant with different topology might be already predeployed.

In general, a preferred algorithm shall support any P2MP PON topology.

In an optical access network, we can count only on connectivity from the OLT to every ONU (downstream traffic) and every ONU to the OLT (upstream traffic); this is true for all PON topologies. Therefore, the OLT remains the only device that can arbitrate time-division access to the shared channel.

The challenge of implementing an OLT-based dynamic arbitration scheme is in the fact that the OLT does not know how many bytes of data each ONU has buffered. The burstiness of data traffic precludes a queue occupancy prediction of any reasonable accuracy. If the OLT is to make an accurate time slot assignment, it should know the state of a given ONU exactly.

One solution may be to use a polling scheme based on Grant and Request messages. Requests are sent from an ONU to report changes in an ONU's state. The OLT processes all Requests and allocates different transmission windows (time slots) to ONUs. Slot assignment information is delivered to ONUs using Grant messages.

The advantage of having centralized intelligence for the slot allocation algorithm is that the OLT knows the state of the entire network and can switch to another allocation scheme based on that information; the ONUs don't need to negotiate or acknowledge new parameters, nor switch to new settings synchronously, making ONUs simpler and cheaper, and the entire network more robust.

Choosing the best allocation scheme, however, is not a trivial task. If all users belong to the same administrative domain (say a corporate or campus network), full statistical multiplexing would make sense; network administrators would like to get the most out of the available bandwidth. However, subscriber access networks are not private LANs, and the objective is to ensure SLA compliance for each individual user. Using statistical multiplexing mechanisms to get each user best effort bandwidth may complicate billing and potentially may offset the user's drive to upgrade to a higher bandwidth. Also, subscribers may get used to and expect the performance they get during low-activity hours when lots of best-effort bandwidth is available. Then, at peak hours, the same users would perceive service as unsatisfactory, even though they get what is guaranteed by their SLA. An optimized bandwidth allocation algorithm will ultimately depend on the future SLA and billing model used by service providers.

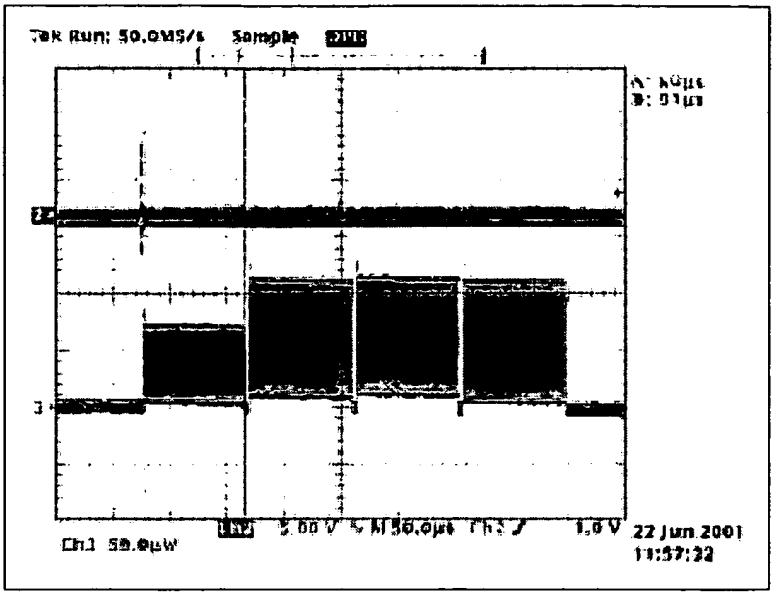
Transceiver Issues

Due to unequal distances between central office and ONUs, optical signal attenuation in the PON is not the same for each ONU. The power level received at the OLT will be different for each ONU (the so-called *near-far* problem). Figure 6 depicts power levels received by an OLT from four different ONUs. As shown, one ONU's signal strength is lower at the OLT, most likely due to its longer distance.

To properly detect the incoming bitstream, the OLT receiver must be able to quickly adjust its zero-one threshold at the beginning of each received time slot (i.e., it should operate in *burst mode)*. A burst mode receiver is necessary only in the OLT. The ONUs read a continuous bitstream (data or idles) sent by the OLT and do not need to readjust quickly.

An alternative approach may be to allow ONUs to adjust their transmitter power such that power levels received by the OLT from all ONUs become the same. This method is not particularly favored by transceiver designers because it makes the ONU hardware more complicated, requires special signaling protocol for feedback from the OLT to each ONU, and, most important, may degrade the performance of all ONUs to that of the most distant unit.

Another issue is that it is not enough just to disallow ONUs to send any data (i.e., send only zeros). The problem is that even in the absence of data, lasers generate spontaneous emission noise. Spontaneous emission noise from several ONUs located close to the OLT can easily obscure the signal from a distant ONU. Thus, an ONU must shut down its laser between time slots. Also, it is important that the laser be able to stabilize quickly after being turned on.



■ **Figure 6.** *An illustration of the near-far problem: a snapshot of received power level from four ONUs.*

Security

Security has never been a strong part of Ethernet networks. In P2P full-duplex Ethernet security is not a critical issue because there are only two communicating stations using a private channel. In shared half-duplex Ethernet, security concerns are minimized because users belong to a single administrative domain and are subject to same set of policies.

P2MP Ethernet, however, has a different set of requirements. EPON has a broadcasting downstream channel and serves noncooperative users. In fact, an EPON cannot be considered a peer-to-peer network in that ONUs cannot communicate directly with each other (unless purposely provisioned to) or even learn of each other's existence. Since a malicious ONU may be placed in promiscuous mode and read all downstream packets, encryption mechanisms are necessary. Encryption and decryption may be implemented at the physical layer, data link layer, or higher layers. Implementing encryption above the MAC layer will encrypt the MAC frame payload only, and leave headers in plain text. Frame check sequence (FCS) is calculated for the encrypted payload. In this scenario, a MAC sublayer will verify the received frame integrity before passing the payload to a higher sublayer for decryption. This scheme prevents malicious ONUs from reading the payload, but they may still learn other ONUs' MAC addresses.

Alternatively, encryption can be implemented in the physical layer (abbreviated as PHY) below the MAC. In this scheme, the PHY layer will

In this scheme no information may be learned by a malicious ONU. But the difficulty is that PHY by definition is a connection-less layer. Requiring the PHY in an OLT to apply different keys for different ONUs will make it connection-aware. Encryption in EPON still remains an open question.

encode the entire bitstream, including the frame headers and CRC. At the receiving end, the PHY layer will decrypt the data before passing it to the MAC for verification. Since encryption keys are different for different ONUs, frames not destined to a given ONU will not decrypt into a properly formed frame and will be rejected by the MAC. In this scheme no information may be learned by a malicious ONU. But the difficulty is that PHY by definition is a connectionless layer. Requiring the PHY in an OLT to apply different keys for different ONUs will make it connection-aware. Encryption in EPON still remains an open question.

Service Requirements

The migration of TDM circuit-switched networks to IP packet-switched networks is progressing at a rapid pace. However, although the next-generation access network will be optimized for IP data traffic, legacy equipment (RF set-top boxes, analog TV sets, TDM private branch exchangess, etc.) and legacy services (T1/E1s, ISDN, POTS, analog video, etc) will remain in use in the foreseeable future. Therefore, it is critical for next-generation access networks, such as EPONs, to be able to provide both IP-based services and jitter-sensitive and time-critical legacy services that have traditionally not been the focus of Ethernet.

Fortunately, EPONs can be designed to carry best-effort data as well as time-critical voice and video. This is typically accomplished using QoS techniques such as prioritization, VLAN tagging, reservations, and bandwidth provisioning. Several carriers, ranging from cable companies to large incumbent carriers, have deployed Gigabit EPONs delivering voice, data, and video.

The issue in implementing a circuit-over-packet emulation scheme is mostly related to clock distribution. In one scheme, users provide a clock to their respective ONUs, which is in turn delivered to the OLT. But since the ONUs cannot transmit all the time, the clock information must be delivered in packets. The OLT will regenerate the clock using this information. It is somewhat trivial to impose a constraint that the OLT should be a clock master for all downstream ONU devices. In this scenario, the ONUs will recover the clock from its receive channel, use it in its transmit channel, and distribute it to all legacy devices as a secondary clock reference.

IEEE P802.3ah Status

The standards work for Ethernet in the local subscriber access network is being done in the IEEE P802.3ah Ethernet in the First Mile (EFM) Task Force. This group received approval to operate as a Task Force from the IEEE-SA Standards Board in September 2001.

The P802.3ah EFM Task Force is bringing Ethernet to the local subscriber loop, focusing on both residential and business access networks. While at first glance this appears a simple task, in reality the requirements of local exchange carriers are vastly different than those of enterprise managers for which Ethernet was designed. In order to "evolve" Ethernet for local subscriber networks, P802.3ah is focused on four primary standards definitions:

- Ethernet over copper
- Ethernet over P2P fiber
- Ethernet over P2MP fiber
- Operation, administration, and maintenance (OAM)

Thus, the EFM Task Force is focused on both copper and fiber standards, optimized for the first mile and glued together by a common OAM system. This is a particularly strong vision, since it allows a local network operator a choice of Ethernet flavors using a common hardware and management platform. In each of these subject areas, new PHY specifications are being discussed to meet the requirements of service providers while preserving the integrity of Ethernet. Standards for EFM are anticipated by September 2003, with baseline proposals emerging as early as March 2002.

The Ethernet over P2MP track is focusing on the lower layers of an EPON network. This involves a PHY specification, with possibly minimal modifications to the 802.3 MAC. The standards work for P2MP fiber-based Ethernet is in progress, with a P2MP protocol framework emerging. This emerging protocol uses MAC control messaging (similar to the Ethernet PAUSE message) to coordinate multipoint-to-point upstream Ethernet frame traffic. Materials concerning the P802.3ah standards effort can be found at www.ieee802.org/3/efm and presentation materials at www.ieee802.org/ 3/efm/public.

The Market for EPONs

Although many sectors of the telecommunications industry are suffering from the slowdown in service provider capital expenditures, analysts still expect the optical access market to grow rapidly. CIBC forecasts the market for PON access systems to reach $1 billion by 2004 from $23 million in 2000 [9]. Unlike the backbone network, which received an abundance of investment in long-haul fiber routes during the Internet boom, optical technology has not been widely deployed in the access network. It is possible that EPONs and P2P optical Ethernet offer the best possibility of a turnaround in the telecom sector. Service providers investing in optical access technologies will enable new applications, stimulating revenue growth and driving more traffic onto backbone routes. The large increase in access network bandwidth provided by EPONs and P2P optical Ethernet will eventually stimulate renewed investment in metro and long-haul fiber routes.

Conclusion

The subscriber access network is constrained by equipment and infrastructure not originally designed for high-bandwidth IP data. Whether riding on shorter copper drops or optical fiber, Ethernet is emerging as the future broadband protocol of choice, offering plug and play simplicity, IP efficiency, and low cost. Of particular interest are Ethernet PONs, which combine low-cost point-to-multipoint optical infrastructure with low-cost high-bandwidth Ethernet. The future broadband access network is likely to be a

combination of point-to-point and point-to-multipoint Ethernet, optimized for transporting IP data, as well as time critical voice and video.

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The future broadband access network is likely to be a combination of point-to-point and point-to-multipoint Ethernet, optimized for transporting IP data, as well as time critical voice and video.

An Encryption Scheme for High Speed Passive Optical Networks

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Abstract

The prohibitive cost of dedicated fiber local loops for residential customers led to the development of passive optical networks (PONs) for access to broadband services. However the passive splitting of optical signals which gives flexibility, low cost and robustness creates a broadcast physical topology compromising customer privacy. Encryption is the only cost-effective way to prohibit global reception and create the required point-to-point logical links restoring confidentiality to the desirable degree. Because of the very high speed of such networks, only solutions amenable to hardware implementations are acceptable. ATM cells are allocated to the system users on a time division basis each encrypted with a different key. A suitable for the PON environment encryption solution based on the summation generator stream cipher is presented with an outline of its hardware implementation.

1. Introduction

Access networks represent the most cost-sensitive part of the communication infrastructure since they cover the links of the customers to the network which are unique for each domestic site and must be directly or indirectly paid by the corresponding customer. Low traffic intensities and low sharing of infrastructure lead to slow return on investment making the undertaking of an upgrade to higher rates a risky project. For these reasons, shared architectures such as Passive Optical Networks (PONs) in combination with the Asynchronous Transfer Mode (ATM) are considered one of the most promising solutions for the introduction of broadband services to residential users. They feature a tree-like architecture, with the root of the tree positioned in a central place and the terminals (leafs) scattered around 10 Km away [11], or even 100km in the case of SuperPONs [12]. The trunk and the main branches of the network consist of optical fibers in common use. Only the last drop is dedicated. Statistical multiplexing of ATM cells effected with the help of the Medium Access Control (MAC) protocol can dynamically adjust bandwidth distribution among many traffic streams based on momentary needs, and so lower the per user cost of the infrastructure. Even without taking into account the multiplexing gain prospects which are significant for most applications (Video on Demand (VoD), Internet access, LAN emulation, etc.) the efficiency of Time Division Multiple Access (TDMA) can not be ignored. Traffic concentration is both desirable and possible in the local loop with its cost sensitivity.

Because of the topology of the network several peculiar problems arise relating to the sharing of medium and providing privacy and security. The main security threat comes from the fact that all downstream information is broadcast to every user. Special fast encryption methods are needed to realize a cost-effective, robust and secure network. Guided by the framework of ETSI STAG [13], we identify the threats, and security services/measures/objectives of a PON. Although the threats arising in a PON place at risk all three dimensions of security (confidentiality, integrity, authenticity), in this paper we mainly concentrate on the confidentiality issue and propose an encryption scheme to restore the lost privacy.

2. A typical PON system architecture

The dominant feature of a PON architecture is its tree topology with a central point at the root of the tree through which all traffic has to pass. Optical splitters divide the signal into N equal copies in the downstream direction (from head-end to customers) whereas they multiplex the upstream transmissions into a single stream directed to the local switch (Fig.1). TDMA (Time Division Multiple Access) multiplexing of cells is adopted

since it has emerged as the most effective method. For the proper operation of the TDMA method, the cells transmitted upstream must combine in a way creating a train of cells without catastrophic overlaps (Fig. 2) and with a minimal and controlled intercell spacing (guardband). Thus a train of slots must be created by the physical layer. The formation of this train and all related problems of sharing the common medium are controlled by the MAC sublayer [11], which uses an overhead at the beginning of the ATM cells, the size of which depends on a lot of factors but when oversampling [9] is employed, it can stay at no more than two bytes. To tap the efficiency and the multiplexing gain promised by TDMA, a dynamic MAC protocol is needed. Reservation on a cell basis has been the method of choice for dynamic protocols [11].

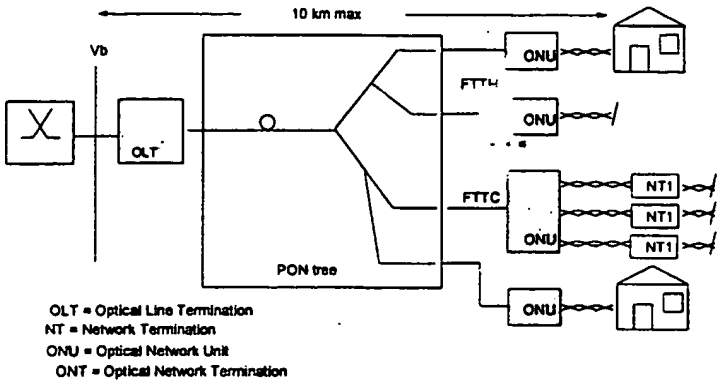


Fig. 1. Typical access PON architecture

Similar in principle is the set-up of a SuperPON with the addition of Optical Amplifiers which increase the available power budget to offer a higher splitting ratio and a longer range, reaching up to 15000 customers. Regarding security, there are no significant differences between the PON and the SuperPON except for quantitative ones stemming from the higher rates and number of users. The method proposed herewith designed for a SuperPON is also applicable to a normal PON.

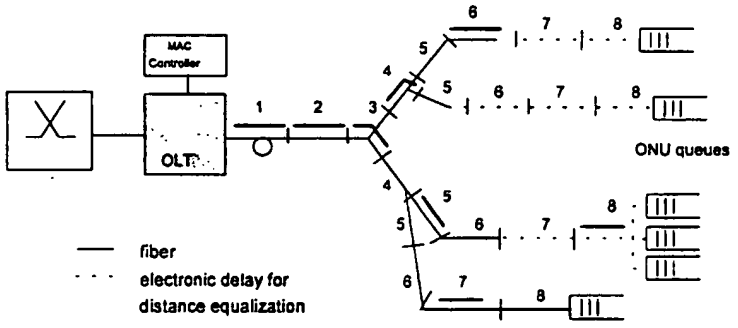


Fig. 2. TDMA multiplexing of ATM cells

3. Services and Threats

The services typically offered on a PON are the following:.

- PSTN (i.e. POTS, FAX),
- ISDN- based (tele-working, video-telephony),
- "On Demand" services (i.e. Video on Demand),
- on-line services (e.g. Internet access, file transfer),
- digital broadcasting (i.e. Near Video on Demand, Digital Video Broadcasting), e.t.c.

In line with the mandates of [13], the security measures required in a PON are:

- Confidentiality of user data,
- confidentiality of signaling data,
- authentication of user/user device to network,
- authentication of network to user/user device,
- integrity of user data,
- integrity of signaling information e.t.c.

The threats facing a PON based access system include in addition to those usually found in a communication network, novel ones arising from the peculiarities of the topology, components and usage. PONs are no more vulnerable to external abuse than usual fiber networks as regards malicious users not connected on the same tree. Very different is the case for users connected to the same tree who attempt to eavesdrop or disrupt normal usage. This malicious activity can now take place from one's home by exploiting the accessibility afforded by the shared medium topology. It is the main mandate of encryption to deny malicious users the possibility of eavesdropping. To this end it is employed at the ATM level, in contrast (or in addition) to application level encryption. It should be noted that whatever measures are taken by the PON, only cover the access part and are not applicable end-to-end. Therefore, services with strict security requirements will anyway resort to encryption at the presentation layer even if no methods to analyse and decrypt PON information existed. The objective of the PON encryption is to restore for the ordinary services (which today are offered without ciphering but rely on whatever privacy is offered by the dedicated medium), the same privacy level as enjoyed with a private cable, counteracting the physical broadcast downstream topology.

4. The proposed encryption solution for PONs

So, in a PON network, encryption has the important role of turning the inherent broadcast downstream architecture into a point-to-point one. Thus although on the physical level all information still reaches all customers, each one should be able to decrypt and understand only the cells addressed to him. In contrast, the upstream direction is much less vulnerable. The only concern arises from the reflections of the upstream signals on the optical splitters. These reflections are detectable but most probably not readable at the customer premises. The proposed solution could be applied to both directions in the event that the reflections prove to be a security risk.

The requirements dictated by the PON environment on the encryption system are the following:

- The security objectives of PONs are to reach a security level similar to the one existing in the Universal Mobile Telecommunication Service (UMTS) networks which also have a broadcast physical topology and face similar threats, (i.e. to require as much effort and cost to eavesdrop as in a UMTS network).

- There should be a minimum sacrifice of bandwidth.

- The system should not have an indirect impact on the MAC protocol leading to a more complex MAC.

- The system should not lead to higher loss of data.

Under the above considerations we propose an encryption system using the Summation Generator, which is based on stream ciphers and can offer easy and fast hardware implementation matching the high speed of PON networks and particularly the SuperPONs.

A stream cipher specifies a device with internal memory that enciphers the jth digit p_j of the plaintext stream into the jth digit c_j of the ciphertext stream using an XOR function which depends on both the key k and the internal state of the stream cipher at time j.

A stream ciphering system is considered secure if it satisfies the following requirements.

Period : The keystream sequence should have a long period.
Linear Complexity: The length of the shortest Linear Feedback Shift Registers (LFSRs) able to produce the keystream sequence must be large. (The keystream sequence should have noise-like characteristics).
Statistical Tests : The keystream sequence should satisfy all statistical tests (frequency, binary derivative, change point, poker, runs, sequence complexity, linear complexity, universal) [4].
Correlation Immunity: The sequence should have high order correlation immunity.
The summation generator (see Figure 3) due to Rueppel [7] consists of n LFSRs, whose length is pairwise relatively prime, and one memory bit. The LFSRs produce the sequences a(i,t) for i=1,...,n and a memory bit sequence s(t).
The output bit sequence (key stream) z(t) is defined by

$$z(t) = \sum_{i=1}^{n} a(i,t) \oplus s(t-1)$$

$$s(t) = \sum_{i=1}^{n-1} a(i,t)\left(\sum_{j=i+1}^{n} a(j,t) \right) \oplus \sum_{i=1}^{n} a(i,t)s(t-i) \quad .$$

The keys of the summation generator consist of the initial state vectors, the tap settings of the LFSRs, and the initial values of the memory bit s(t-1).

The period has length $(2^{l1}-1)...(2^{li}-1) ... (2^{ln}-1)$ where li represents the length of the n LFSRs (A number n=8 was selected in this application). Although the summation generator has been cryptanalyzed initially for a number of LFSRs equal to 3 [1], while recently methodologies for an analysis for any number of LFSR have been devised [14], [15], an analytic attack requires very significant effort compared to the value of the information contained in those residential services not protected by further application level encryption.

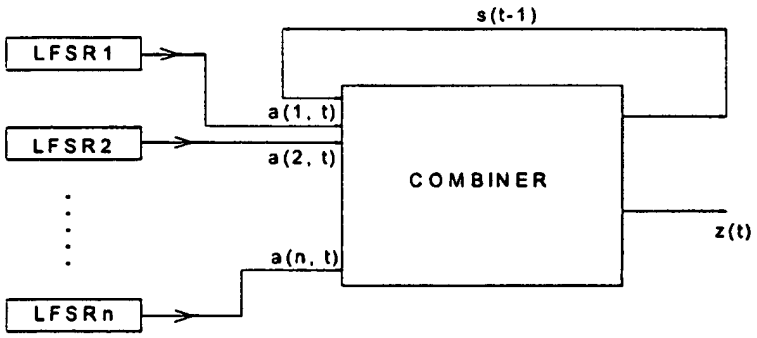


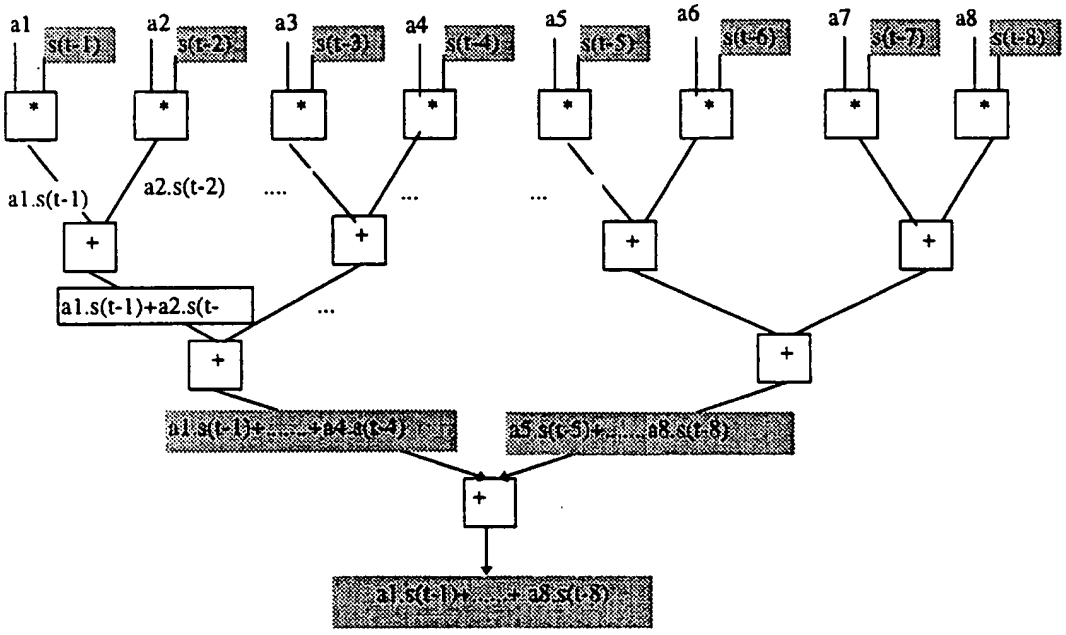
Fig.3. The summation generator

A hardware implementation of the summation generator in the case of a SuperPON is outlined below. The impact on the implementation of each expression of the above equations will be investigated.

The double sum in the second equation uses values of a(i,t) that are independent of the corresponding values of s(t-i). This means with enough adders in the ASIC we can perform parallel computation of the sums referring to the time t with those referring to the times t+1, t+2, etc and have them available when needed. This way the calculation of the nested sum causes no extra delay in the execution time of the whole algorithm.. The number of adders necessary for that are about 2n, and can be easily coorporated in an ASIC.

The sum of the first equation has a dependance on the value of s(t-1) which means that for computing this we need an extra step after the value of s(t-1) has been calculated. The most time critical computation is that of the second sum of the second equation, i.e. $\sum_{i=1}^{n} a(i,t)s(t-i)$ which has dependencies on all former n values of the expression s(t-i) and its execution cannot begin not even in part before the computation of s(t-1). In a normal serial execution, it would require n steps, i.e. n clock times. It can however be computed in parallel by using n adders. The numbers of steps can then be $\log_2 n$ and the minimum necessary time is $\log_2 n$ clock times. That means that for n=8 we need 3 clock times. The same time is needed also for n=5 to 7, which explains the choice of 8 LFSRs.

A typical diagram for the parallel execusion of this sum is given in Figure 4 below.



Notes: All values of a are at the moment (t)
Each row shows one computing step, i.e. one clock time.

Figure 4. Parallel Execution of the sum.

As seen from the above discussion, the whole decryption procedure can be performed in 5 steps (4 for the sums and 1 for the EXOR function), which needs 5 clock times. The total number of necessary flip-flops is about 500, which can be easily corporated in an ASIC, or even an FPGA.

Given that the High Speed PONs can have a bitrate of hundred or even thousands of Mbps, and that chips can now achieve propagation delays of a few nano-seconds, it is clear that even in the case of parallel computation, we are short of the desired speed by a factor of 5 to 10, if we want to make on line encryption on the downstream transmission of PONs.

There are two ways to alleviate the speed problem; cipher per connection or per ONU.

In the first case, the encryption is done at much lower speed independently for each connection (VPI/PCI value) before multiplexing to the downstream. The disadvantage is that we should have as many encryption engines and keys as the possible number of simultaneous connections, which can be many thousands in a SuperPON. Still those of high bit rate connections will have to be hardware based. An advantage is that we will only load once the key to initialize the encryption and decryption engines, however directing each cell to the appropriate engine after inspecting its VCI/VPI requires considerable circuitry for such a high number of engines.

In the second case, the encryption is done at lower speed for separate groups of connections before their multiplexing. In a SuperPON the downstream transmission consists essentially of 16x155Mbps streams which are bit interleaved to form the 2.4Gbps full stream. Each ONU receives only one of these streams (or two; one for interactive and one for distributive services). Therefore 16 engines operating at 155Mbps are enough and can fit in one ASIC. This solution leads to a much lower number of encryption engines, but still each engine supports time multiplexed cells directed to different ONUs which must be ciphered using different keys. Hence the values of the cipher-text found in the registers after the encryption of a cell, should be stored to be reloaded when the next cell for the same ONU arrives, while those of the destination ONU of the current cell should be recalled for encryption to proceed. No such storing of register values is necessary at the ONU engines. Simply the engine is paused while no cells destined for that ONU arrive and restarts where it stopped with the next cell (or byte in case of POTS supported by composite cells).

PONs have many terminal optical units (ONUs), most of which serve more than one customer. Since each ONU is connected to its users through dedicated lines, the special security problems that exist in PONs, do not arise between the ONU and its customers. So decryption takes place in ONUs and the information is forwarded to the terminals in the form it had arrived at the OLT, since the last drop provides no different security than any dedicated link currently in use in the access.

It is worth noting that the fact that all connections through an ONU are encrypted with the same session key does not reduce the security of the system, since ONUs belong to the operator and tampering with them is as difficult (or as easy) as with any part of a public network.

5. Key management

The keys for the summation generator cipher are the initial settings of the registers of the encryption engine. All engines are identical and given the same initial settings they produce the same sequence. The need for the change of a key can arise either from loss of synchronization (i.e., different values of the registers at the first bit of a cell) of the engines or other faulty conditions detected by fault management, or, most likely, from periodic key updates.

Errors of the encrypted information bits, which can happen at the prevailing BER of the link, do not lead to the loss of synchronization, because both OLT and ONU in order to run or to stop the encryption engines calculate simply the number of bits encrypted/decrypted each time, which is constant (the number of bits in a cell or a byte) and do not depend on the bits themselves. Misreception of some bits leads to the loss of information which is contained in these bits, the same if they are encrypted or not, and do not have any effect in the production of the ciphertext.

Although the sequence produced by the proposed summation generator is very long, and practically suffices for the transmission of data for many days, it is good practice to change the keys often to minimize the damage from broken keys. We note that in PON networks is very easy to obtain encrypted plain-text. A malicious user can send a message to the user whose machine he wants to attack. If he has an ONU at his disposal (which is the case for the fiber to the home), he will also receive the message in the encrypted form (since all information goes to all ONUs) and by adding to it modulo 2 the message that he has sent, he will have the ciphertext. From this however he cannot find the initial register settings, so that this ciphertext is useless since the same will never be re-used.

Changing keys requires the exchange of OAM cells, so the frequency of change is only limited by the required overhead for frequent changes. Since an analysis of the summation generator has become possible since the time this work was first submitted, [14], [15], a frequent key change will keep the benefit from a successful attack low. One approach is to change keys during times of reduced traffic exploiting idle slots.

Responsibility for the key management belongs to the OLT which distributes in a secure way the secret encryption keys to the ONUs. The procedure followed to change the key is the following. Public key encryption is used. The OLT sends to the corresponding ONU an Operation And Maintenance (OAM) cell with a change key command to announce that a session key is requested. When the ONU receives this cell it calculates the new session key. In order to prevent an intruder to force a key change the new session key has to be certified by the ONU. We will use the Rivest-Shamir-Adleman (RSA) [6] scheme to achieve this goal. Each ONU generates two large prime number p, q (greater or equal to 2^r, where r is the length of the session key). Compute n=pq. Choose a number e such that the numbers e and (p-1)(q-1) are relative prime. Compute $d=e^{-1} \bmod (p-1)(q-1)$. The numbers e, n are the public keys, and d is the private key which only ONU knows. The ONU signs the message with the new session key M using its private key and he sends the signed message $S=M^d \bmod n$ to the OLT via the secure upstream channel. Upon reception, the OLT checks the authenticity of the message by checking whether $S^e \bmod n=M$.

To ensure that both OLT and ONU have the same key The ONU attaches a verification block which is a known header to the plaintext message before encryption. When OLT decrypts the verification block it verifies whether it is correct. Although this gives an intruder plaintext information to cryptanalyze the system with a known plaintext attack, this will not be feasible in our case since the summation generator used is not vulnerable to such an attack.

6. Conclusions

Sharing the OLT and the feeder fiber by means of PONs or SuperPONs reduces the per customer cost of access to broadband services but at the same time privacy is compromised. To rectify this problem resort to cell level encryption is adopted. Because of the high speed, hardware based solutions must be chosen. A stream cipher solution based on the summation generator is found suitable for the purpose in combination with a public key management scheme. One engine per 155Mbps stream can be implemented in a high speed logic circuit with the presented architecture. Since the encryption is not applied end-to-end, there is no point in pursuing a more expensive scheme. Particularly demanding services such as tele-banking will still need additional measures at application level which however will be at much lower speed.

Acknowledgments:

This work was partially funded by the ACTS project AC050 PLANET (Passive Local Access NETworks).
The authors wish to thank professors E. Dawson and A. Clapper for kindly providing preprints of their papers [14], and [15] correspondingly.

ALLOPTIC

Ethernet Passive Optical Networks

Definition

Ethernet passive optical networks (EPON) are an emerging access network technology that provides a low-cost method of deploying optical access lines between a carrier's central office (CO) and a customer site. EPONs build on the International Telecommunications Union (ITU) standard G.983 for asynchronous transfer mode PONs (APON) and seek to bring to life the dream of a full-services access network (FSAN) that delivers converged data, video, and voice over a single optical access system.

Overview

The communications industry is on the cusp of a revolution that will transform the landscape. This revolution is characterized by three fundamental drivers. First, deregulation has opened the local loop to competition, launching a whole new class of carriers that are spending billions to build out their networks and develop innovative new services. Second, the rapid decline in the cost of fiber optics and Ethernet equipment is beginning to make them an attractive option in the access network. Third, the Internet has spawned genuine demand for broadband services, leading to unprecedented growth in Internet protocol (IP) data traffic and putting pressure on carriers to upgrade their networks.

These drivers are, in turn, promoting two new key market trends. First, deployment of fiber optics is extending from the backbone to the wide-area network (WAN) and the metropolitan-area network (MAN) and will soon penetrate into the local loop. Second, Ethernet is spreading from the local-area network (LAN) to the MAN and the WAN as the uncontested standard.

The convergence of these factors is leading to a fundamental paradigm shift in the communications industry, a shift that will ultimately lead to widespread adoption of a new optical IP Ethernet architecture that combines the best of fiber optics and Ethernet technologies. This architecture is poised to become the dominant means of delivering bundled data, video, and voice services over a single platform.

This tutorial discusses the economics, technological underpinnings, features and benefits, and history of EPONs.

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Topics

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2. Economic Case for Ethernet PONs
3. Passive Optical Network Architecture
4. Active Network Elements
5. How Ethernet PONs Work
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Self-Test

Correct Answers

Glossary

1. Evolution of Passive Optical Networks

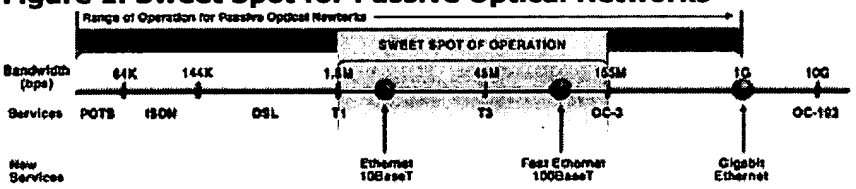
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Typically, only large enterprises can afford to pay the $3,200 – $4,300 per month it costs to lease a T3 (45 Mbps) or optical carrier (OC)–3 (155 Mbps) SONET connection. T1s at $375 per month are an option for some medium-size enterprises, but most small and medium-size enterprises and residential customers are left with few options beyond plain old telephone service (POTS) and dial-up Internet access. Where available, digital subscriber line (DSL) and cable modems offer a more affordable interim solution for data, but they are difficult and time-consuming to provision. In addition, bandwidth is limited by distance and by the quality of existing wiring; and voice services have yet to be widely implemented over these technologies.

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Figure 1. Sweet Spot for Passive Optical Networks



PONs aim to break the last-mile bandwidth bottleneck by targeting the sweet spot between T1s and OC–3s that other access network technologies do not adequately address.

The two primary types of PON technology are asynchronous transfer mode PONs (APONs) and Ethernet PONs (EPONs).

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At that time the two logical choices for protocol and physical plant were ATM and PON: ATM because it was thought to be suited for multiple protocols, PON because it is the most economical broadband optical solution. The APON format used by FSAN was accepted as an International Telecommunications Union (ITU) standard (ITU–T Rec. G.983). The ITU standard focused primarily on residential applications and in its initial version did not include provisions for delivering video services over the PON. Subsequently, a number of start-up vendors introduced APON–compliant systems that focused exclusively on the business market.

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EPONs

The development of EPONs has been spearheaded by one or two visionary start-ups that feel that the APON standard is an inappropriate solution for the local loop because of its lack of video capabilities, its insufficient bandwidth, its complexity, and its expense. Also, as the move to fast Ethernet, gigabit Ethernet, and now 10-gigabit Ethernet picks up steam, these start-ups believe that EPONs will eliminate the need for conversion in the wide-area network (WAN)/LAN connection between ATM and IP protocols.

EPON vendors are focusing initially on developing fiber-to-the-business (FTTB) and fiber-to-the-curb (FTTC) solutions, with the long-term objective of realizing a full-service fiber-to-the-home (FTTH) solution for delivering data, video, and voice over a single platform. While EPONs offer higher bandwidth, lower costs, and broader service capabilities than APON, the architecture is broadly similar and adheres to many G.983 recommendations.

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2. Economic Case for Ethernet PONs

The economic case for EPONs is simple: fiber is the most effective medium for transporting data, video, and voice traffic, and it offers virtually unlimited bandwidth. But the cost of running fiber "point-to-point" from every customer location all the way to the CO, installing active electronics at both ends of each fiber, and managing all of the fiber connections at the CO is prohibitive. EPONs address the shortcomings of point-to-point fiber solutions by using a point-to-multipoint topology instead of point-to-point in the outside plant; by eliminating active electronic components, such as regenerators, amplifiers, and lasers, from the outside plant; and by reducing the number of lasers needed at the CO.

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Table 1. Comparison of Point-to-Point Fiber Access and EPONs

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There are a number of limitations inherent to this architecture: (1) it is fiendishly difficult to provision because each network element (NE) in an ATM path must be provisioned for each service; (2) it is optimized for time division multiplex (TDM) voice—not data—so its fixed bandwidth channels have difficulty handling bursty data traffic; (3) it requires inefficient and expensive optical-to-electrical-to-optical (O–E–O) conversion at each network node; (4) it requires installation

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Self-Test

Correct Answers

Glossary

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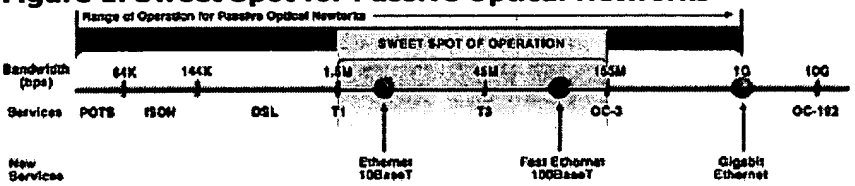
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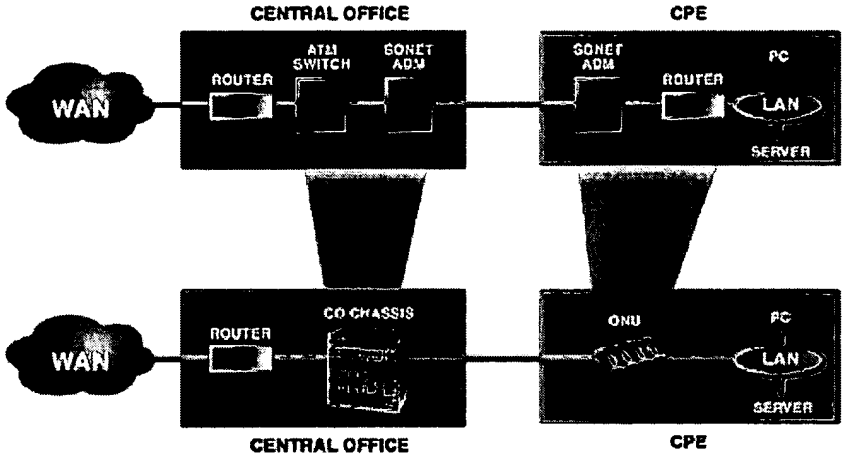
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of all nodes up front (because each node is a regenerator); and (5) it does not scale well because of its connection-oriented virtual circuits.

In the example of a streamlined EPON architecture in *Figure 2*, an ONU replaces the SONET ADM and router at the customer premises, and an OLT replaces the SONET ADM and ATM switch at the CO.

Figure 2. Streamlined EPON Architecture



This architecture offers carriers a number of benefits. First, it lowers up front capital equipment and ongoing operational costs relative to SONET and ATM. Second, an EPON is easier to deploy than SONET/ATM because it requires less complex hardware and no outside plant electronics, which reduces the need for experienced technicians. Third, it facilitates flexible provisioning and rapid service reconfiguration. Fourth, it offers multilayered security, such as virtual LAN (VLAN) closed user groups and support for virtual private network (VPN), IP security (IPSec), and tunneling. Finally, carriers can boost their revenues by exploiting the broad range and flexibility of services offerings available over an EPON architecture. This includes delivering bandwidth in scalable increments from 1 to 100 Mbps up to 1 Gbps and value-added services, such as managed firewalls, voice traffic support, VPNs, and Internet access.

3. Passive Optical Network Architecture

The passive elements of an EPON are located in the optical distribution network (also known as the outside plant) and include single-mode fiber-optic cable, passive optical splitters/couplers, connectors, and splices. Active NEs, such as the OLT and multiple ONUs, are located at the end points of the PON. Optical signals traveling across the PON are either split onto multiple fibers or combined onto a single fiber by optical splitters/couplers, depending on whether the light is traveling up or down the PON. The PON is typically deployed in a single-fiber,

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ALLOPTIC

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Correct Answers

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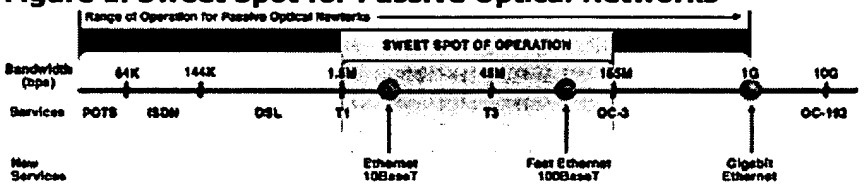
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Active electronic components are required at the end of each fiber and in the outside plant.	Eliminates active electronic components, such as regenerators and amplifiers, from the outside plant and replaces them with less-expensive passive optical couplers that are simpler, easier to maintain, and longer lived than active components
Each subscriber requires a separate fiber port in the CO.	Conserves fiber and port space in the CO by passively coupling traffic from up to 64 optical network units (ONU) onto a single fiber that runs from a neighborhood demarcation point back to the service provider's CO, head end, or POP
Expensive active electronic components are dedicated to each subscriber	Cost of expensive active electronic components and lasers in the optical line terminal (OLT) is shared over many subscribers

Unlike point-to-point fiber-optic technology, which is optimized for metro and longhaul applications, EPONs are tailor-made to address the unique demands of the access network. Because they are simpler, more efficient, and less expensive than alternative access solutions, EPONs finally make it cost-effective for service providers to extend fiber into the last mile and to reap all the rewards of a very efficient, highly scalable, low-maintenance, end-to-end fiber-optic network.

The key advantage of an EPON is that it allows carriers to eliminate complex and expensive asynchronous transfer mode (ATM) and SONET elements and to simplify their networks dramatically. Traditional telecom networks use a complex, multilayered architecture, which overlays IP over ATM, SONET, and WDM. This architecture requires a router network to carry IP traffic, ATM switches to create virtual circuits, add/drop multiplexers (ADM) and digital cross-connects (DCS) to manage SONET rings, and point-to-point DWDM optical links.

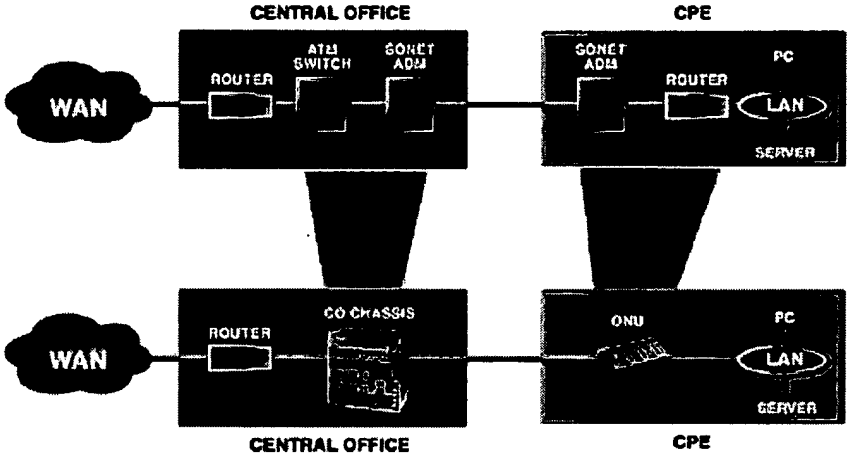
There are a number of limitations inherent to this architecture: (1) it is fiendishly difficult to provision because each network element (NE) in an ATM path must be provisioned for each service; (2) it is optimized for time division multiplex (TDM) voice—not data—so its fixed bandwidth channels have difficulty handling bursty data traffic; (3) it requires inefficient and expensive optical-to-electrical-to-optical (O–E–O) conversion at each network node; (4) it requires installation

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of all nodes up front (because each node is a regenerator); and (5) it does not scale well because of its connection-oriented virtual circuits.

In the example of a streamlined EPON architecture in *Figure 2*, an ONU replaces the SONET ADM and router at the customer premises, and an OLT replaces the SONET ADM and ATM switch at the CO.

Figure 2. Streamlined EPON Architecture



This architecture offers carriers a number of benefits. First, it lowers up front capital equipment and ongoing operational costs relative to SONET and ATM. Second, an EPON is easier to deploy than SONET/ATM because it requires less complex hardware and no outside plant electronics, which reduces the need for experienced technicians. Third, it facilitates flexible provisioning and rapid service reconfiguration. Fourth, it offers multilayered security, such as virtual LAN (VLAN) closed user groups and support for virtual private network (VPN), IP security (IPSec), and tunneling. Finally, carriers can boost their revenues by exploiting the broad range and flexibility of services offerings available over an EPON architecture. This includes delivering bandwidth in scalable increments from 1 to 100 Mbps up to 1 Gbps and value-added services, such as managed firewalls, voice traffic support, VPNs, and Internet access.

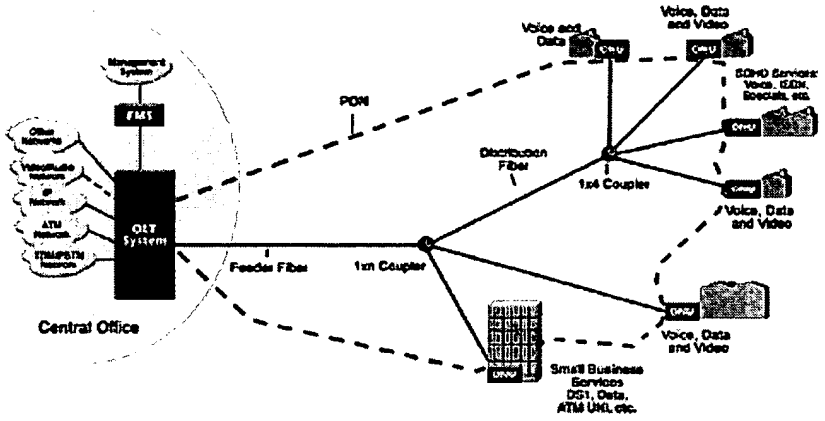
3. Passive Optical Network Architecture

The passive elements of an EPON are located in the optical distribution network (also known as the outside plant) and include single-mode fiber-optic cable, passive optical splitters/couplers, connectors, and splices. Active NEs, such as the OLT and multiple ONUs, are located at the end points of the PON. Optical signals traveling across the PON are either split onto multiple fibers or combined onto a single fiber by optical splitters/couplers, depending on whether the light is traveling up or down the PON. The PON is typically deployed in a single-fiber,

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point-to-multipoint, tree-and-branch configuration for residential applications. The PON may also be deployed in a protected ring architecture for business applications or in a bus architecture for campus environments and multiple-tenant units (MTU).

Figure 3. Passive and Active NEs of a PON



4. Active Network Elements

EPON vendors focus on developing the "active" electronic components—such as the CO chassis and ONUs—that are located at both ends of the PON. The CO chassis is located at the service provider's CO, head end, or POP and houses OLTs, network interface modules (NIM), and the switch card module (SCM). The PON connects an OLT card to 64 ONUs, each located at a home, business, or MTU. The ONU provides customer interfaces for data, video, and voice services, as well network interfaces for transmitting traffic back to the OLT.

CO Chassis

The CO chassis provides the interface between the EPON system and the service provider's core data, video, and telephony networks. The chassis also links to the service provider's core operations networks through an element management system (EMS). WAN interfaces on the CO chassis will typically interface with the following types of equipment:

- DCSs, which transport nonswitched and non–locally switched TDM traffic to the telephony network. Common DCS interfaces include digital signal (DS)–1, DS–3, synchronous transport signal (STS)–1, and OC–3.

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- Voice gateways, which transport locally switched TDM/voice traffic to the public-switched telephone network (PSTN)
- IP routers or ATM edge switches, which direct data traffic to the core data network
- Video network devices, which transport video traffic to the core video network
- Key functions and features of the CO chassis include the following:
- Multiservice interface to the core WAN
- Gigabit Ethernet interface to the PON
- Layer-2 and -3 switching and routing
- Quality of service (QoS) issues and service-level agreements (SLA)
- Traffic aggregation
- Houses OLTs and SCM

Optical Network Unit

The ONU provides the interface between the customer's data, video, and telephony networks and the PON. The primary function of the ONU is to receive traffic in an optical format and convert it to the customer's desired format (Ethernet, IP multicast, POTS, T1, etc.). A unique feature of EPONs is that, in addition to terminating and converting the optical signal, the ONUs provide Layer-2 and -3 switching functionality, which allows internal routing of enterprise traffic at the ONU. EPONs are also well suited to delivering video services in either analog CATV format, using a third wavelength, or IP video.

Because an ONU is located at every customer location in FTTB and FTTH applications and the costs are not shared over multiple subscribers, the design and cost of the ONU is a key factor in the acceptance and deployment of EPON systems. Typically, the ONUs account for more than 70 percent of the system cost in FTTB deployments, and in FTTH deployments they account for approximately 80 percent.

Key features and functions of the ONU include the following:

- Customer interfaces for POTS, T1, DS–3, 10/100BASE-T, IP multicast, and dedicated wavelength services

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- Layer-2 and -3 switching and routing capabilities
- Provisioning of data in 64 kbps increments up to 1 Gbps
- Low start-up costs and plug-and-play expansion
- Standard Ethernet interfaces eliminate the need for additional DSL or cable modems

EMS

The EMS manages the different elements of the PON and provides the interface into the service provider's core operations network. Its management responsibilities include the full range of fault, configuration, accounting, performance, and security (FCAPS) functions.

Key features and functions of the EMS include the following:

- Full FCAPS functionality via a modern graphical user interface (GUI)
- Capable of managing dozens of fully equipped PON systems
- Supports hundreds of simultaneous GUI users
- Standard interfaces, such as common object request broker architecture (CORBA), to core operations networks

5. How Ethernet PONs Work

The key difference between EPONs and APONs is that in EPONs, data is transmitted in variable-length packets of up to 1,518 bytes according to the IEEE 802.3 protocol for Ethernet, whereas in APONs, data is transmitted in fixed-length 53-byte cells (with 48-byte payload and five-byte overhead), as specified by the ATM protocol. This format means it is difficult and inefficient for APONs to carry traffic formatted according to the IP. The IP calls for data to be segmented into variable-length packets of up to 65,535 bytes. For an APON to carry IP traffic, the packets must be broken into 48-byte segments with a 5-byte header attached to each one. This process is time consuming and complicated and adds additional cost to the OLT and ONUs. Moreover, 5 bytes of bandwidth are wasted for every 48-byte segment, creating an onerous overhead that is commonly referred to as the "ATM cell tax." By contrast, Ethernet was tailor-made for carrying IP traffic and dramatically reduces the overhead relative to ATM.

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Managing Upstream/Downstream Traffic in an EPON

In an EPON, the process of transmitting data downstream from the OLT to multiple ONUs is fundamentally different from transmitting data upstream from multiple ONUs to the OLT. The different techniques used to accomplish downstream and upstream transmission in an EPON are illustrated in *Figures 4* and *5*.

In *Figure 4*, data is broadcast downstream from the OLT to multiple ONUs in variable-length packets of up to 1,518 bytes, according to the IEEE 802.3 protocol. Each packet carries a header that uniquely identifies it as data intended for ONU–1, ONU–2, or ONU–3. In addition, some packets may be intended for all of the ONUs (broadcast packets) or a particular group of ONUs (multicast packets). At the splitter, the traffic is divided into three separate signals, each carrying all of the ONU–specific packets. When the data reaches the ONU, it accepts the packets that are intended for it and discards the packets that are intended for other ONUs. For example, in *Figure 4*, ONU–1 receives packets 1, 2, and 3; however, it delivers only packet 1 to end user 1.

Figure 4. Downstream Traffic Flow in an EPON

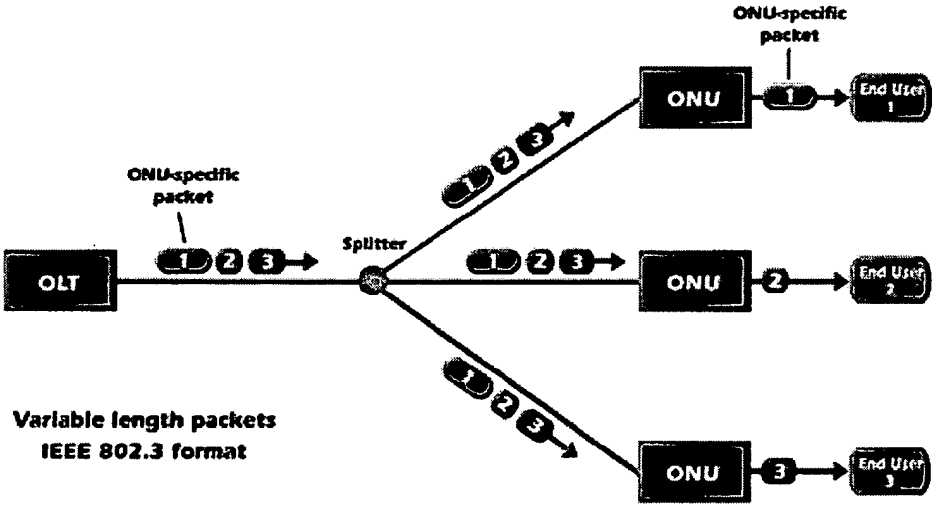
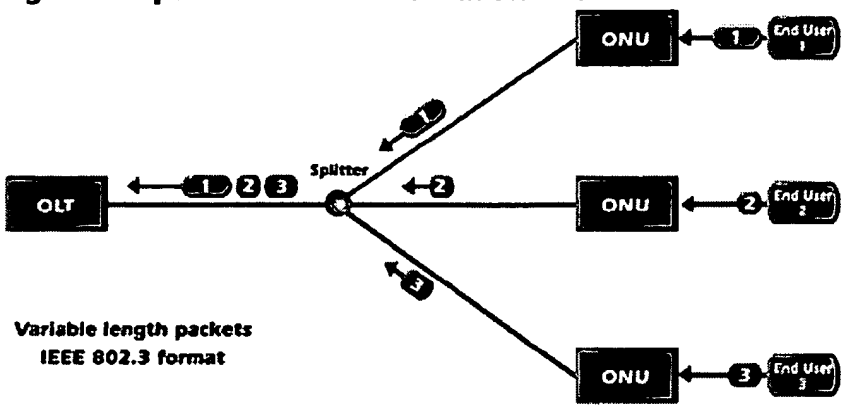


Figure 5 shows how upstream traffic is managed utilizing TDM technology, in which transmission time slots are dedicated to the ONUs. The time slots are synchronized so that upstream packets from the ONUs do not interfere with each other once the data is coupled onto the common fiber. For example, ONU–1 transmits packet 1 in the first time slot, ONU–2 transmits packet 2 in a second non-overlapping time slot, and ONU–3 transmits packet 3 in a third non-overlapping time slot.

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Figure 5. Upstream Traffic Flow in an EPON



EPON Frame Formats

Figure 6 depicts an example of downstream traffic that is transmitted from the OLT to the ONUs in variable-length packets. The downstream traffic is segmented into fixed-interval frames, each of which carries multiple variable-length packets. Clocking information, in the form of a synchronization marker, is included at the beginning of each frame. The synchronization marker is a one-byte code that is transmitted every 2 ms to synchronize the ONUs with the OLT.

Each variable-length packet is addressed to a specific ONU as indicated by the numbers, 1 through *N*. The packets are formatted according to the IEEE 802.3 standard and are transmitted downstream at 1 Gbps. The expanded view of one variable-length packet shows the header, the variable-length payload, and the error-detection field.

Figure 6. Downstream Frame Format in an EPON

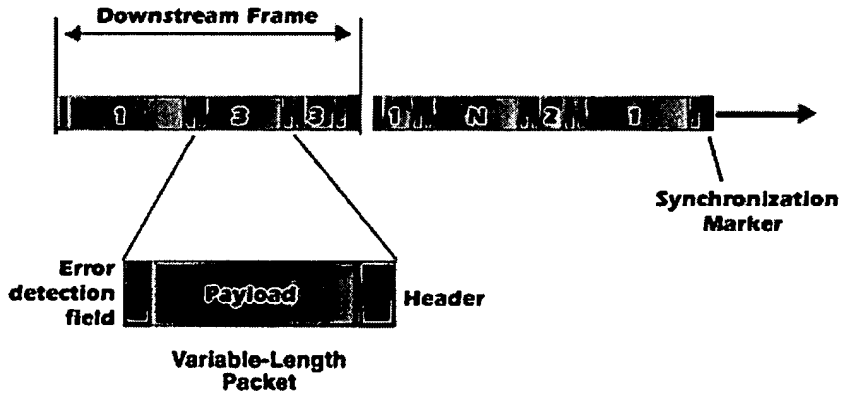


Figure 7 depicts an example of upstream traffic that is TDMed onto a common optical fiber to avoid collisions between the upstream traffic from each ONU. The

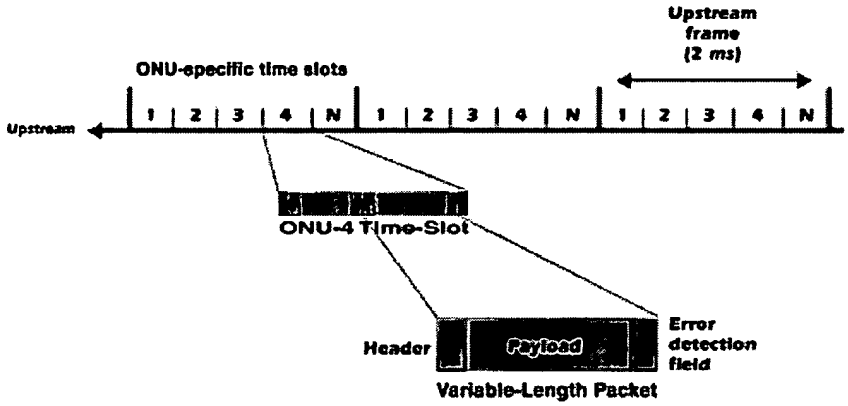
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upstream traffic is segmented into frames, and each frame is further segmented into ONU–specific time slots. The upstream frames are formed by a continuous transmission interval of 2 ms. A frame header identifies the start of each upstream frame.

The ONU–specific time slots are transmission intervals within each upstream frame that are dedicated to the transmission of variable-length packets from specific ONUs. Each ONU has a dedicated time slot within each upstream frame. For example, in *Figure 7*, each upstream frame is divided into *N* time slots, with each time slot corresponding to its respective ONU, 1 through *N*.

The TDM controller for each ONU, in conjunction with timing information from the OLT, controls the upstream transmission timing of the variable-length packets within the dedicated time slots. *Figure 8* shows an expanded view of the ONU–specific time slot (dedicated to ONU–4) that includes two variable-length packets and some time-slot overhead. The time-slot overhead includes a guard band, timing indicators, and signal power indicators. When there is no traffic to transmit from the ONU, a time slot may be filled with an idle signal.

Figure 7. Upstream Frame Format in an EPON



6. Optical System Design

EPONs can be implemented using either a two-wavelength or a three-wavelength design. The two-wavelength design is suitable for delivering data, voice, and IP–switched digital video (SDV). A three-wavelength design is required to provide radio frequency (RF) video services (CATV) or dense wavelength division multiplexing (DWDM).

Figure 8 shows the optical layout for a two-wavelength EPON. In this architecture, the 1510 nm wavelength carries data, video, and voice downstream, while a 1310 nm wavelength is used to carry video-on-demand (VOD)/channel change requests, as well as data and voice, upstream. Using a 1.25 Gbps

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bidirectional PON, the optical loss with this architecture gives the PON a reach of 20 km over 32 splits.

Figure 8. Optical Design for Two-Wavelength EPON

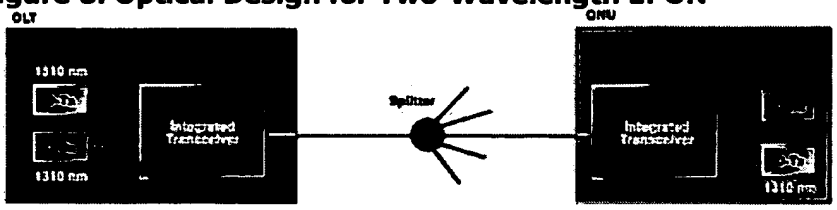
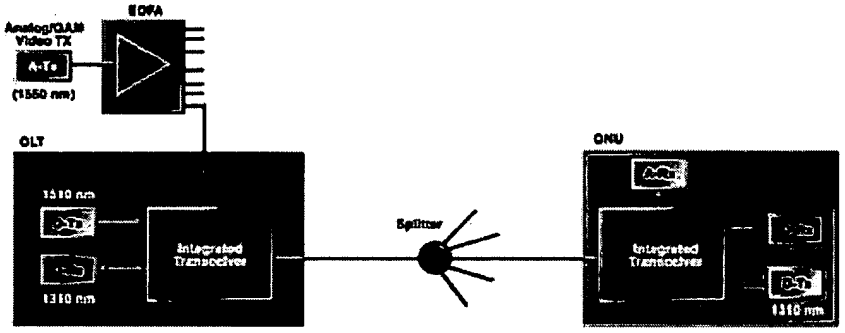


Figure 9 shows the optical layout for a three-wavelength EPON. In this architecture, 1510 nm and 1310 nm wavelengths are used in the downstream and the upstream directions respectively, while the 1550 nm wavelength is reserved for downstream video. The video is encoded as Moving Pictures Experts Group–Layer 2 (MPEG2) and is carried over quadrature amplitude modulation (QAM) carriers. Using this setup, the PON has an effective range of 18 km over 32 splits.

Figure 9. Optical Design for Three-Wavelength EPON



The three-wavelength design can also be used to provide a DWDM overlay to an EPON. This solution uses a single fiber with 1510 nm downstream and 1310 nm upstream. The 1550 nm window (1530–1565 nm) is left unused, and the transceivers are designed to allow DWDM channels to ride atop the PON transparently. The PON can then be deployed with no DWDM components, while allowing future DWDM upgrades to provide wavelength services, analog video, increased bandwidth, etc. In this context, EPONs offer an economical setup cost, which scales effectively to meet future demand.

7. Quality of Service

EPONs offer many cost and performance advantages that enable service providers to deliver revenue-generating services over a highly economical platform. However, a key technical challenge for EPON vendors lies in enhancing Ethernet's capabilities to ensure that real-time voice and IP video services can be

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delivered over a single platform with the same QoS and ease of management as ATM or SONET.

EPON vendors are attacking this problem from several angles. The first is to implement methods, such as differentiated services (DiffServ) and 802.1p, which prioritize traffic for different levels of service. One such technique, TOS Field, provides eight layers of prioritization to make sure that the packets go through in order of importance. Another technique, called bandwidth reserve, provides an open highway with guaranteed latency for POTS traffic so that it does not have to contend with data.

To illustrate some of the different approaches to emulating ATM/SONET service capabilities in an EPON, *Table 2* highlights four key objectives that ATM and SONET have been most effective at providing: (1) the quality and reliability required for real-time services; (2) statistical multiplexing to manage network resources effectively; (3) multiservice delivery to allocate bandwidth fairly among users; (4) tools to provision, manage, and operate networks and services; and (5) full system redundancy and restoration.

In every case, EPONs have been designed to deliver comparable services and objectives using Ethernet and IP technology. Sometimes this has required the development of innovative techniques, which are not adequately reflected in literal line-by-line adherence to ATM or SONET standards and features.

Table 2. Comparison of ATM, SONET, and EPON Service Objectives and Solutions

Objective	ATM/SONET Solution	Ethernet PON Solution
Real-time services	ATM service architecture and connection-oriented design ensure the reliability and quality needed for real-time service.	A routing/switching engine that offers native IP/Ethernet classification with advanced admission control, bandwidth guarantees, traffic shaping, and network resource management that extends significantly beyond the Ethernet solutions found in traditional enterprise LANs
Statistical multiplexing	Traffic shaping and network resource management allocates bandwidth fairly between users of non–real-time services Dynamic bandwidth allocation implementation needed.	Traffic-management functionality across the internal architecture and the external interface with the MAN EMS provides coherent policy based traffic management across OLTs and ONUs. IP traffic flow is inherently bandwidth conserving (statistical multiplexing).
Multiservice delivery	These characteristics work together to ensure that fairness is maintained among different services coexisting on a	Service priorities and SLAs assure that network resources are always available for a customer-specific service. Gives service provider control of "walled-garden"

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	common network.	services, such as CATV and interactive IP video.
Management capabilities	A systematic provisioning framework and advanced management functionality enhance the operational tools available to manage the network.	Integrating EMS with service providers' OSSs emulates the benefits of connection-oriented networks and facilitates end-to-end provisioning, deployment, and management of IP services.
Protection	Bidirectional line-switched ring (BLSR) and unidirectional path-switched ring (UPSR) provide full system redundancy and restoration.	Counter-rotating ring architecture provides protection switching in sub 50 ms intervals.

These techniques allow EPONs to deliver the same reliability, security, and QoS as more expensive SONET and ATM solutions.

- Guaranteed QoS using TOS Field and DiffServ
- Full system redundancy providing high availability and reliability
- Diverse ring architecture with full redundancy and path protection
- Multilayered security, such as VLAN closed user groups and support for VPN, IPSec, and tunneling

8. Applications

EPONs address a variety of applications for incumbent local-exchange carriers (ILEC), cable multiple-system operators (MSO), competitive local-exchange carriers (CLEC), building local-exchange carriers (BLEC), overbuilders (OVB), utilities, and emerging start-up service providers. These applications can be broadly classified into three categories:

- Cost reduction: reducing the cost of installing, managing, and delivering existing services
- New revenue opportunities: boosting revenue-earning opportunities through the creation of new services
- Competitive advantage: increasing carrier competitiveness by enabling more rapid responsiveness to new business models or opportunities

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Cost-Reduction Applications

EPONs offer service providers unparalleled opportunities to reduce the cost of installing, managing, and delivering existing service offerings. For example, EPONs do the following:

- Replace active electronic components with less expensive passive optical couplers that are simpler, easier to maintain, and longer lived
- Conserve fiber and port space in the CO
- Share the cost of expensive active electronic components and lasers over many subscribers
- Deliver more services per fiber and slash the cost per megabit
- Promise long-term cost-reduction opportunities based on the high volume and steep price/performance curve of Ethernet components
- Save the cost of truck rolls because bandwidth allocation can be done remotely
- Free network planners from trying to forecast the customer's future bandwidth requirement because the system can scale up easily

For service providers the result is lower capital costs, reduced capital expenditures, and higher margins.

Case Study: T1 Replacement

ILECs realize that T1 services are their "bread and butter" in the business market. However, T1 lines can be expensive to maintain and provision, particularly where distance limitations require the use of repeaters. Today, most T1s are delivered over copper wiring, but service providers have already recognized that fiber is more cost-effective when demand at a business location exceeds four T1 lines.

EPONs provide the perfect solution for service providers that want to consolidate multiple T1s on a single cost-effective fiber. By utilizing a PON, service providers eliminate the need for outside plant electronics, such as repeaters. As a result, the expense required to maintain T1 circuits can be reduced dramatically. In many cases, savings of up to 40 percent on maintenance can be achieved by replacing repeatered T1 circuits with fiber-based T1s.

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New Revenue Opportunities

New revenue opportunities are a critical component of any service provider's business plan. Infrastructure upgrades must yield a short-term return on investment and enable the network to be positioned for the future. EPON platforms do exactly that by delivering the highest bandwidth capacity available today, from a single fiber, with no active electronics in the outside plant. The immediate benefit to the service provider is a low initial investment per subscriber and an extremely low cost per megabit. In the longer term, by leveraging an EPON platform, carriers are positioned to meet the escalating demand for bandwidth as well as the widely anticipated migration from TDM to Ethernet solutions.

Case Study: Fast Ethernet and Gigabit Ethernet

Increasing growth rates for Ethernet services have confirmed that the telecommunications industry is moving aggressively from a TDM orientation to a focus on Ethernet solutions. Fast Ethernet (10/100BT) is expected to grow at a rate of 25.2 percent compound annual growth rate (CAGR) 1999–2004 (IDC, June 2000). Gigabit Ethernet is experiencing an extremely rapid growth of 128.9 percent CAGR 1999–2004 (IDC, June 2000). It is imperative that incumbent carriers, MSOs, and new service providers embrace these revenue streams. The challenge for the ILEC is how to implement these new technologies aggressively without marginalizing existing products. For new carriers, it is critical to implement these technologies with a minimum of capital expenditure. MSOs are concerned about how best to leverage their existing infrastructure while introducing new services.

EPONs provide the most cost-effective means for ILECs, CLECs, and MSOs to roll out new, higher-margin fast Ethernet and gigabit Ethernet services to customers. Data rates are scalable from 1 Mbps to 1 Gbps, and new equipment can be installed incrementally as service needs grow, which conserves valuable capital resources. In an analysis of the MSO market, an FTTB application delivering 10/100BASE-T and T1 circuits yielded a one-month payback (assuming a ratio of 70 percent 10/100BASE-T to 30 percent T1, excluding fiber cost).

Competitive Advantage

Since the advent of the Telecommunications Act of 1996, competition has been on the increase. However, the current state of competition has been impacted by the capital crisis within the service-provider community. CLECs today are increasingly focused on market niches that provide fast growth and short-term return on investment.

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Incumbent carriers must keep focused on core competencies while defending market-share, and, at the same time, they must look for high-growth new product opportunities. One of the most competitive niches being focused on is the Ethernet space. Long embraced as the de facto standard for LANs, Ethernet is used in more than 90 percent of today's computers. From an end-user perspective, Ethernet is less complex and less costly to manage. Service providers, both incumbent and new entrants, are providing these services as both an entry and defensive strategy. From the incumbent perspective, new entrants that offer low-cost Ethernet connectivity will take market-share from legacy products. As a defensive strategy, incumbents must meet the market in a cost-effective, aggressive manner. EPON systems are an extremely cost-effective way to maintain a competitive edge.

Case Study: Enabling New Service-Provider Business Models

New or next-generation service providers know that a key strategy in today's competitive environment is to keep current cost at a minimum, with an access platform that provides a launch pad for the future. EPON solutions fit the bill. EPONs can be used for both legacy and next-generation service, and they can be provisioned on a pay-as-you-go-basis. This allows the most widespread deployment with the least up-front investment.

For example, a new competitive service provider could start by deploying a CO chassis with a single OLT card feeding one PON and five ONUs. This simple, inexpensive architecture enables the delivery of eight DS–1, three DS–3, 46 100/10BASE-T, one gigabit Ethernet (DWDM), and two OC–12 (DWDM) circuits, while leaving plenty of room in the system for expansion. For a new service provider, this provides the benefit of low initial start-up costs, a wide array of new revenue-generating services, and the ability to expand network capacity incrementally as demand warrants.

9. Benefits of Ethernet PONs

EPONs are simpler, more efficient, and less expensive than alternate multiservice access solutions. Key advantages of EPONs include the following:

- Higher bandwidth: up to 1.25 Gbps symmetric Ethernet bandwidth
- Lower costs: lower up-front capital equipment and ongoing operational costs
- More revenue: broad range of flexible service offerings means higher revenues

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Higher Bandwidth

EPONs offer the highest bandwidth to customers of any PON system today. Downstream traffic rates of 1 Gbps in native IP have already been achieved, and return traffic from up to 64 ONUs can travel in excess of 800 Mbps.

The enormous bandwidth available on EPONs provides a number of benefits:

- More subscribers per PON
- More bandwidth per subscriber
- Higher split counts
- Video capabilities
- Better QoS

Lower Costs

EPON systems are riding the steep price/performance curve of optical and Ethernet components. As a result, EPONs offer the features and functionality of fiber-optic equipment at price points that are comparable to DSL and copper T1s. Further cost reductions are achieved by the simpler architecture, more efficient operations, and lower maintenance needs of an optical IP Ethernet network.

EPONs deliver the following cost reduction opportunities:

- Eliminate complex and expensive ATM and SONET elements and dramatically simplify network architecture
- Long-lived passive optical components reduce outside plant maintenance
- Standard Ethernet interfaces eliminate the need for additional DSL or cable modems
- No electronics in outside plant reduces need for costly powering and right-of-way space

More Revenue

EPONs can support a complete bundle of data, video, and voice services, which allows carriers to boost revenues by exploiting the broad range and flexibility of service offerings available. In addition to POTS, T1, 10/100BASE-T, and DS-3,

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EPONs support advanced features, such as Layer-2 and -3 switching, routing, voice over IP (VoIP), IP multicast, VPN 802.1Q, bandwidth shaping, and billing. EPONs also make it easy for carriers to deploy, provision, and manage services. This is primarily because of the simplicity of EPONs, which leverage widely accepted, manageable, and flexible Ethernet technologies.

Revenue opportunities from EPONs include:

- Support for legacy TDM, ATM, and SONET services
- Delivery of new gigabit Ethernet, fast Ethernet, IP multicast, and dedicated wavelength services
- Provisioning of bandwidth in scalable 64 kbps increments up to 1 Gbps
- Tailoring of services to customer needs with guaranteed SLAs
- Quick response to customer needs with flexible provisioning and rapid service reconfiguration

Table 3. Summary of EPON Features and Benefits

Features	Benefits
ONUs provide internal IP address translation, which reduces the number of IP addresses and interfaces with PC and data equipment over widely used Ethernet interfaces.	Customer configuration changes can be made without coordination of ATM addressing schemes that are less flexible.
ONU offers similar features to routers, switches and hubs at no additional cost.	Consolidates functions into one box, simplifies network, and reduces costs
Software-activated VLANs	Allows service providers to generate new service revenues
Implement firewalls at the ONU without need for separate PC	Allows service providers to generate new service revenues
Full system redundancy to the ONU provides high availability and reliability (five 9s).	Allows service providers to guarantee service levels and avoid costly outages
Self-healing network architecture with complete back-up databases	Allows rapid restoration of services with minimal effort in the event of failure
Automatic equipment self-identification	Facilitates services restoration upon equipment recovery or card replacement
Remote management and software upgrades	Simplifies network management,

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	reduces staff time, and cuts costs
Status of voice, data, and video services for a customer or group of customers can be viewed simultaneously.	Facilitates better customer service and reduces cost of handling customer inquiries
ONUs have standard Ethernet customer interface.	Eliminates need for separate DSL and/or cable modems at customer premises and lowers cost

10. Ethernet in the First Mile Initiative

EPON vendors are actively engaged in a new study group that will investigate the subject of EFM. Established under the auspices of the IEEE, the new study group aims to develop a standard that will apply the proven and widely used Ethernet networking protocol to the access market.

The EFM study group was formed within the IEEE 802.3 carrier sense multiple access with collision detection (CSMA/CD) Working Group in November 2000. Sixty-nine companies, including 3Com, Alloptic, Aura Networks, CDT/Mohawk, Cisco Systems, DomiNet Systems, Intel, MCI WorldCom, and World Wide Packets, have indicated they will participate in the group.

In addition to the IEEE study group, EPON vendors are planning to participate in other standards efforts conducted within organizations, such as the Internet Engineering Task Force (IETF), ITU–Telecommunications Standardization Sector (ITU–T), and the Standards Committee T1. There is even the possibility of a liaison with FSAN on this effort. The FSAN document does not preclude non–ATM protocols, and the FSAN document is broad in scope (covering many last-mile issues). Much of G.983 remains valid, and it could be that the IEEE 802.3 EFM group will focus on developing the MAC protocols for EPON, referencing FSAN for everything else. This is the quickest path to an EPON standard, and several big names, including Cisco Systems and Nortel Networks, are backing EPON over APON.

11. The Future of Ethernet PONs

EPONs are in the early phases of commercial development with initial trial deployments anticipated during 2001. Although APONs have a slight head start in the marketplace, current industry trends—including the rapid growth of data traffic and the increasing importance of fast Ethernet and gigabit Ethernet services—favor Ethernet PONs. Standardization efforts are already underway based on the establishment of the EFM study group, and momentum is building for an upgrade to the FSAN–initiated APON standard.

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The stage is set for a paradigm-shift in the communications industry that could well result in a completely new "equipment deployment cycle," firmly grounded in the wide-based adoption of fiber optics and Ethernet technologies. This optical IP Ethernet architecture promises to become the dominant means of delivering bundled voice, data, and video services over a single network. In addition, this architecture is an enabler for a new generation of cooperative and strategic partnerships, which will bring together content providers, service providers, network operators, and equipment manufacturers to deliver a bundled entertainment and communications package unrivaled by any other past offering.

Self-Test

1. Also known as the access network or local loop, the _____ consists predominantly, in residential areas, of copper telephone wires or coaxial cable television (CATV) cables.

 a. customer premises

 b. hardware

 c. last mile

 d. network

2. _____ address the shortcomings of point-to-point fiber solutions by using a point-to-multipoint topology instead of point-to-point in the outside plant; by eliminating active electronic components, such as regenerators, amplifiers, and lasers, from the outside plant; and by reducing the number of lasers needed at the CO.

 a. EPONs

 b. Engineers

 c. APONs

 d. ONUs

3. The passive elements of an EPON are located in the _____ (also known as the outside plant) and include single-mode fiber-optic cable, passive optical splitters/couplers, connectors, and splices.

 a. MTUs

 b. optical distribution network

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c. customer premises

d. CO chassis

4. The _____ provides the interface between the EPON system and the service provider's core data, video, and telephony networks.

 a. optical distribution network

 b. customer premises

 c. MTUs

 d. CO chassis

5. Which of the following is a feature or function of the EMS?

 a. supports hundreds of simultaneous GUI users

 b. full FCAPS functionality via a modern graphical user interface (GUI)

 c. capable of managing dozens of fully equipped PON systems

 d. all of the above

6. EPONs can be implemented using either a two-wavelength or a three-wavelength design.

 a. true

 b. false

7. Decreasing growth rates for Ethernet services have confirmed that the telecommunications industry is moving aggressively from Ethernet solutions to a TDM orientation.

 a. true

 b. false

8. EPONs offer the highest bandwidth to customers of any PON system today.

 a. true

 b. false

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9. EPON vendors are actively engaged in a new study group known as _____ that will develop a standard that will apply the proven and widely used Ethernet networking protocol to the access market.

 a. LMA

 b. ITU

 c. EFM

 d. IEEE

Correct Answers

1. Also known as the access network or local loop, the _____ consists predominantly, in residential areas, of copper telephone wires or coaxial cable television (CATV) cables.

 a. customer premises

 b. hardware

 c. last mile

 d. network

 See Topic 1.

2. _____ address the shortcomings of point-to-point fiber solutions by using a point-to-multipoint topology instead of point-to-point in the outside plant; by eliminating active electronic components, such as regenerators, amplifiers, and lasers, from the outside plant; and by reducing the number of lasers needed at the CO.

 a. EPONs

 b. Engineers

 c. APONs

 d. ONUs

 See Topic 2.

3. The passive elements of an EPON are located in the _____ (also known as the outside plant) and include

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single-mode fiber-optic cable, passive optical splitters/couplers, connectors, and splices.

a. MTUs

b. optical distribution network

c. customer premises

d. CO chassis

See Topic 3.

4. The _____ provides the interface between the EPON system and the service provider's core data, video, and telephony networks.

 a. optical distribution network

 b. customer premises

 c. MTUs

 d. CO chassis

 See Topic 4.

5. Which of the following is a feature or function of the EMS?

 a. supports hundreds of simultaneous GUI users

 b. full FCAPS functionality via a modern graphical user interface (GUI)

 c. capable of managing dozens of fully equipped PON systems

 d. all of the above

 See Topic 4.

6. EPONs can be implemented using either a two-wavelength or a three-wavelength design.

 a. true

 b. false

 See Topic 6.

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7. Decreasing growth rates for Ethernet services have confirmed that the telecommunications industry is moving aggressively from Ethernet solutions to a TDM orientation.

 a. true

 b. false

 See Topic 8.

8. EPONs offer the highest bandwidth to customers of any PON system today.

 a. true

 b. false

 See Topic 8.

9. EPON vendors are actively engaged in a new study group known as _____ that will develop a standard that will apply the proven and widely used Ethernet networking protocol to the access market.

 a. LMA

 b. ITU

 c. EFM

 d. IEEE

 See Topic 9.

Glossary

ADM
add/drop multiplexer

APON
asynchronous transfer mode passive optical network

ATM
asynchronous transfer mode

BLEC
building local-exchange carrier

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BLSR
bidirectional line-switched ring

CAGR
compound annual growth rate

CATV
cable television

CLEC
competitive local-exchange carrier

CO
central office

CORBA
common object request broker architecture

CSMA/CD
carrier sense multiple access with collision detection

DCS
digital cross-connect

DiffServ
differentiated services

DS
digital signal

DSL
digital subscriber line

DWDM
dense wavelength division multiplexing

EFM
Ethernet in the First Mile [study group]

EMS
element management system

EPON
Ethernet passive optical network

FCAPS
fault, configuration, accounting, performance, and security

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FSAN
full-services access network

FTTB
fiber-to-the-building

FTTC
fiber-to-the-curb

FTTH
fiber-to-the-home

GUI
graphical user interface

IEEE
Institute of Electrical and Electronics Engineers

IETF
Internet Engineering Task Force

ILEC
incumbent local-exchange carrier

IP
Internet protocol

IPSec
Internet protocol security

ITU
International Telecommunications Union

ITU–T
ITU–Telecommunications Standardization Sector

LAN
local-area network

MAN
metropolitan-area network

MPEG2
Moving Pictures Experts Group–Layer 2

MSO
multiple-system operator

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MTU
multiple-tenant unit

NE
network element

NIM
network interface module

OC
optical carrier

O–E–O
optical-to-electrical-to-optical

OLT
optical line terminal

ONU
optical network unit

OVB
overbuilder

PON
passive optical network

POP
point of presence

POTS
plain old telephone service

PSTN
public switched telephone network

QAM
quadrature amplitude modulation

QoS
quality of service

RF
radio frequency

SCM
switch card module

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SDV
switched digital video

SLA
service-level agreement

SONET
synchronous optical network

STS
synchronous transfer mode

TDM
time division multiplex

UPSR
unidirectional path-switched ring

VLAN
virtual local-area network

VOD
video on demand

VoIP
voice over Internet protocol

VPN
virtual private network

WAN
wide-area network

WDM
wavelength division multiplexing

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